INDICATIONS OF THE CREATOR.

EXTRACTS,

BEARING UPON THEOLOGY,

FROM

THE HISTORY AND THE PHILOSOPHY

OF THE

INDUCTIVE SCIENCES.

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DEDICATION.

TO

WILLIAM SMYTH, Esquire,

PROFESSOR OF MODERN HISTORY IN THE UNIVERSITY OF CAMBRIDGE.

My dear Professor Smyth,

I know that you have always felt a peculiar interest in the contemplation of Indications of the Creator, drawn from the Creation in which we live, and from the Philosophy which we are led to frame concerning it: and I think that you will be pleased to see a contribution to this train of thought offered at the present moment. It will be a gratification to me, if, in publishing it, I am allowed to inscribe it to you.

One who, like myself, has for many years enjoyed your friendship, and witnessed your influence in this University, may well rejoice at having an opportunity of offering an open tribute of admiration and regard to the virtues and kindly affections

by which we have so long profited; and of expressing his gratitude for the pleasure and instruction you have so long diffused among us. And I am happy to be able to add that, now, the wider public also has, in your published Lectures, the means of judging of our obligations to you. All may there see that you have, throughout your labours, been zealous and consistent in inculcating those principles of justice and mutual forbearance, of moral purpose in political designs, and moderation in political action, which, so far as they prevail, make the world of human history a more visible representation of the will of its Divine Ruler.

That you may long enjoy the recollection of these your past benefits to us, and of our gratitude to you, is the cordial wish and prayer of,

My dear Professor Smyth,

Your affectionate Friend,

W. WHEWELL.

Trinity College, Cambridge,
Feb. 14, 1845.

PREFACE.

THE following EXTRACTS are now published from a persuasion that they may be interesting to many persons who would be unlikely to read the larger works from which they are taken. The *Philosophy of the Sciences* is necessarily a series of somewhat abstruse dissertations, and is likely to be acceptable only to thoughtful students. The *History of Science* is a subject of a more popular character, yet when the history is carried through all the epochs of all the material sciences, probably but few will accompany the historian through a plan so extensive. But lessons of Natural Theology always find a large class of willing readers, when there is anything of novelty in their form. The reflections which the following pages contain, being those which result from a review of the whole progress of science, and of the principles and processes which have been concerned in that progress, necessarily differ in many respects from those of other writers on Natural Theology.

Perhaps, also, there may be some recommendation of these *Indications of the Creator* in their being the result of researches and reasonings undertaken with no purpose of bringing such indications into view, but with objects of quite another kind. For when an author writes with a theological conclusion set before him from the first, as that to which he must conduct his argument, there may arise a suspicion of a defect of candour and comprehensiveness in what he writes. It may be supposed that he will strain or evade anything that points away from his predetermined end. But a narrative of the whole History of Science, and an analysis of the processes by which sciences have been formed, are undertakings too large, and their course too rigidly determined by their plan, to allow them to be drawn aside by partial and irrelevant considerations. The passages now extracted as having a Theological bearing will be seen, on reference, to flow naturally from the trains of thought with which they are combined in the original works.

The main points to which these extracts refer are the Indications of Design in the Creator, and of a Supernatural Origin of the World; and, as con-

nected with this latter point, the consistency of the Inductive with the Revealed History of the World. I have not attempted to combine the Extracts into a system, but have given them in the order in which they occur in the original works. I have added a short extract from another work, on the subject of the Nebular Hypothesis, bearing on the same questions.

The questions which belong to Natural Theology are, in substance, the same from age to age; but they change their aspect with every advance or supposed advance in the Inductive Sciences. I have (p. 94) endeavoured to shew the assertion to be quite baseless, that, as science advances, final causes recede before it, and disappear one after the other. I have also, I trust, made it appear, by a survey of the whole history of one great science, Physiology, that in that science the Doctrine of Final Causes has been not only consistent with the successive steps of discovery, but has been the great instrument of every step of discovery from Galen to Cuvier.

I have further attempted to explain that the modern doctrine of Unity of Plan in different kinds of animals does not at all necessarily contradict the

Doctrine of Final Causes: that *Morphology* is not necessarily inconsistent with *Teleology*. But I have also had to shew that, in modern times, the two doctrines have been put in opposition to each other. The Morphologists have declared, on the ground of their peculiar views, that they could not allow themselves to ascribe to the Creator any intention. (p. 35.) And probably an impression as if the evidence of Design in the Creator were obscured and weakened, is generally produced by the first aspect of morphological doctrines, in minds eager for new views, and yet led, by their own want of the discoverer's power, to borrow their new views from others.

I have already ventured to express an opinion* that Inductive Minds, those which have been able to discover Laws of Nature, have also commonly been ready to believe in an Intelligent Author of Nature; while Deductive Minds, those which have employed themselves in tracing the consequences of Laws discovered by others, have been willing to rest in Laws, without looking beyond to an Author of Laws. I have taken the liberty also (p. 45) to

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* *Bridgewater Treatise*, Book III. Ch. v. and vi.

apply this remark to the case of the opposition between Teleology and Morphology; and have remarked that Cuvier, the great Zoological Discoverer of our time, was a firm believer in Creative Design, notwithstanding the arguments of the Morphologists who controverted such doctrines. I have, in the following pages, so fully discussed this subject, that it would be superfluous to add anything here, if it were not that, as I have already said, morphological views have a peculiar tendency to appear unfavourable to the belief of final causes, in minds to which they are new.

But as morphological views, when they are first presented, appear to some persons to dim the brightness of those proofs of Creative Design with which we are familiar; so, on the other hand, when a newly discovered instance of Creative Design is first made known to us by the zoological discoverer, it is impossible for most persons not to see in it a clear and strong indication of an Intelligent Creator; however much this conviction may afterwards be obscured and confused by morphological generalities of expression. I have given an example of such a new evidence of design, in Mr. Owen's discoveries

with regard to the process of suckling of the kangaroo (p. 79). I do not think any one, becoming acquainted for the first time with the provisions for this purpose, as described by Mr. Owen, can help receiving the conviction which Mr. Owen expressess, that this is an "irrefragable evidence of creative forethought."

Mr. Owen, in this as in many other parts of his writings, is an instance, in addition to those which I have previously adduced, of the teleological turn of the Inductive Mind. It would be going too far to say, conversely, that those whose minds are not inductive have a bias towards morphology. But yet this would not be too much to say, if morphology were very loosely understood. We should not be surprised at the morphologist coming to conclusions very different from those of the teleological discoverer, if that unity of plan which the morphologists assert, be made to consist in resemblances of the most heterogeneous and fantastical kind; if, for instance, plants were supposed to be analogous to the branching forms of crystallization; or trees growing out of the ground to the electrical brush: if some animals were supposed to fall in with the

supposed unity of plan because they have abundant tail, and ornaments for the head in the form of tufts, crests, or horns, while others occupy an analogous position to these because they are of a soft and sluggish character and abundantly edible: if, again, we have a part of a classification in which some animals are placed because they have been denounced as impure, with other animals because they are wild and striped, and others because they have spines and prickles: if, finally, notions of moral judgments and of symbolism are introduced into natural history, and we are told of classes of animals which are symbolically types of evil. Morphology, pursued with such habits of mind, cannot, we should suppose from all the analogy which the history of science lends us, lead to any solid truth, either in natural history or in philosophy.

There is one morphological doctrine of modern times which has attracted much notice, in consequence of its being imagined to offer a solution of the great difficulty of the uniformitarian theory in geology, namely, the appearance of new species and classes of animals as we proceed from the earlier to the later formations. The morphological doctrine of which I

speak is, that the kinds of animals may be arranged in a series ascending from lower to higher: and that each animal of a higher kind, in the progress of its embryo state, passes through states which are the final condition of the lower kind. The application of this morphological doctrine to geological difficulty is this: that the higher kinds of animals, came later, and were developed from the lower kinds, which came earlier in the series, by new peculiar conditions, operating upon the embryo, and carrying it to a higher stage. Now in the apparent simplicity of this doctrine, thus enunciated in general terms, we have that which recommends it to those who accept such doctrines in their general shape. But the zoologist and the geologist, who can test its general assertions by the special facts with which their researches have made them acquainted, know that the facts do not agree with this doctrine. Without going into detail on this subject, I venture to offer the following remarks.

It is not at all agreed among eminent physiologists*, that animals can be arranged in a series

* I make these remarks on the authority of a physiological friend.

ascending from lower to higher, such that each animal of a higher kind in its embryo state passes through the successive stages of the lower kinds; the characters of these stages being (in the asserted doctrine) taken from the brain and the heart, and man being the highest point of the series. For such physiologists assert, that the brain of the human embryo does not resemble, at any period, however early, the brain of any Mollusk or of any Articulate, which are two of the lower stages. It never passes through a stage comparable or analogous to a permanent condition of the same organ in any Invertebrate Animal. And in like manner the spinal cord in the human vertebræ at no period agrees with the corresponding part of the lower kinds of animals. The moment it becomes visible in the human embryo, it is entirely dorsal in position; while in Mollusks and Articulates a great part, or nearly the whole, is ventral. The same is true of the heart, or center of the vascular system, which has always a different relative position to the great nervous center in the Human Embryo from what it has in any Articulate Animal, and in most Mollusks.

Again; the order of lower and higher stages of

developement of the human embryo, does not agree with the successive stages of animal life at successive periods of the earth's history as disclosed by geology. For even if we were to admit, what has not been proved, that the lowest kind of animal developement, which has been termed *polygastric monads*, exist in the earliest fossiliferous rocks, these rocks also manifest the higher types of Echinodermal, Articulate, and Molluscous Animals; while the human germ, commencing with a form and vital properties analogous to those of the monad, passes from the monad stage at once to the Vertebrate, and never enters or typifies the Radiate, the Articulate, or the Molluscous series of organic forms: whereas these forms of Invertebrates have preceded the Vertebrate forms on the earth's surface according to the best evidence disclosed by geology.

Moreover in the Vertebrate, as well as in the Invertebrate part of the animal series, the asserted order fails. It has been pointed out by others*, that in order to produce the asserted accordance between the order of zoological developement and geological

* *Parker's Magazine,* Feb. 1845, p. 102.

succession, geological facts are misrepresented in the most flagrant manner. For Vertebrate animals do exist in the Silurian rocks, from which the asserted law excludes them. Again; if we are to have a geological period eminently characterized by Saurians, it must be that of the lias and oolites, and not that of the new red sandstone, as asserted in the hypothetical scheme; while one of the Saurians which most approaches the mammalian character, has recently been found in a formation below those in which the more ordinary Saurian forms occur. Again; birds, which the new law places in the oolitic group, have left their traces on the earlier formation of the new red sandstone. The new law finds geological epochs corresponding to some of the orders of quadrupeds, namely the rodents, ruminants, digitigrades, and quadrumans; but it gives no place to the other orders, which might claim one with equal reason, pachyderms, marsupials, plantigrades and edentates. Finally, the law requires the monkey to be placed in the newer tertiaries; whereas their remains have been found in the older tertiaries of France, India, and England.

Further, the doctrine of the developement of the kinds of animals from one kind to another by the

influence of external conditions, is contrary to the conclusions of the most esteemed physiologists, as is stated in the following pages. This doctrine is coupled with the assertion of the origin of living beings without an egg or other living parent. This assertion is at variance with the latest and most careful, as well as with all preceding experiments, of eminent physiologists*. And the tenet that any animal can be advanced to a higher stage by a period of gestation prolonged beyond the usual time, is contrary to all fact. The advancement of the vital organs to more perfect stages of developement requires the stimulus of respiration and muscular action, for which birth is essential. Under these conditions, the organs of animals have been developed beyond their usual state; but, as is stated in the following pages, never to a stage beyond that which characterizes the species.

I have hitherto spoken in general terms of the *stages* of animal organization, meaning by that, such stages as fish, lizard, bird, beast. And I have spoken as if there were, in the question before us, no

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* Owen's *Lectures*, 1843, p. 33.

difficulty, except that of advancing from one of these stages to another. But in fact there have been and are existing on the earth many kinds of fish, many kinds of saurians, many of birds, many of beasts. These have the most various forms and habits, with an internal organization of each, which, though wonderful, is in a great measure intelligible, when considered as designed for the animal's support and perservation according to its habits. But to arrange all these kinds of animals, that is, the whole animal creation, in a series, as successive stages of one line of developements, or of any ramified line; and to make the form and the habits of each the result of the stage of developement at which the animal has arrived; is a mode of speculating which is the opposite of that which all successful zoological speculation has followed, and may be expected to lead to opposite results.

The same imperfection in the evidence would be found, if we were to examine, in other subjects as well as in zoology, the asserted law of the identity of the stages of natural developement of the faculties, ascending from beast to man, with the probable history of mankind. For instance, the view of the

speech of man as of the same nature with the signs by which animals express their feelings and purposes, is a view which leaves out of sight the essential character of language. For the essential nature of language consists, not in its expressing particular feelings and purposes, but in its expressing thoughts and things in a *general* manner. Words express abstract thoughts, each of which may be applied to innumerable particular objects; and Human Reason can deal with thoughts so abstracted, and by means of them, can express Truth, which it is her peculiar privilege to contemplate. There are, in animals, no germs of this power of abstraction, this apprehension of abstract and general Truth. The Instinct of animals cannot become the Reason of man, by any process of developement. We cannot unfold the mind of a spider or a bee into the mind of a geometer.

On the other subjects to which the Extracts refer, it does not appear necessary to add anything to what is there said. The opinions there expressed have been for some time before the world; and are such as, I trust, can give just offence to no one.

Trinity College, Cambridge,
Feb. 14, 1845.

EXTRACTS,

&c.

ASTRONOMY.

THE COPERNICAN SYSTEM.

[About A.D. 1500, Copernicus had satisfied himself of the truth of the Heliocentric Theory, according to which the planets, and the earth as one of them, revolve round the sun as the center of their motions. His book *De Revolutionibus Orbium Celestium* was published in 1543, the year of his death. In 1610 Galileo, having invented a telescope, discovered Jupiter's satellites and the moon-like phases of Venus; and these discoveries supplied additional arguments for the truth of the Copernican system. This system Galileo afterwards defended in his writings, which were on that account condemned as heretical by the Inquisition.]

* The doctrines promulgated by Copernicus excited no visible alarm among the theologians of his own time; we may assign as a reason for this,

* *History of the Inductive Sciences.* Book v. Chap. iii. Sect. 4.

that those who were disposed to assert the sway of authority in all matters of belief, had not yet been roused and ruffled by the aggressions of innovators in philosophy and religion, as they soon afterwards were. Probably, also, we ought to take into account the different temper and circumstances of the ultramontane and Italian learned men. The latter, living under the immediate shadow of the papal chair, were necessarily less bold in their speculations, and less open in their promulgation of any opinions which might have a taint of heresy. This influence operated less strongly in Poland and Germany; and we find no evidence which leads us to deny to these countries the glory of having received the Copernican system of the world, from the first, with satisfaction, and without bigoted opposition. The great religious reform which had its rise in Germany about the time of the promulgation of the Copernican system, showed sufficiently that that was the land where opinions would assert their freedom; and where authority could not, with prudence, urge superfluous claims.

But in Italy the church entertained the persuasion that her authority could not be upheld at all, without maintaining it to be supreme on all points. The spirit of dogmatism of the middle ages had descended upon the ecclesiastical institutions of the seventeenth century; and in consistency with that

spirit, it was criminal to disturb received doctrines, or to separate philosophy from religion. The tenet of the earth being at rest in the center of the universe, was not only a part of the established school-philosophy, but was also, it was conceived, sanctioned by Scripture. The Copernican system, therefore, so far as it came into view, was looked at with suspicion and aversion. But though this system is afterwards, in the official condemnation of it, spoken of as "entertained by many," it never came under the notice of the spiritual judges in any conspicuous manner, till it had been illustrated by Galileo's discoveries, and recommended by his writings.

The story of the condemnation of Galileo by the Inquisition, for asserting the motion of the earth, and of his formal renunciation of this doctrine in the presence of his judges, has been so often told, that I need not here repeat the details. It rather belongs to our purpose to consider what lessons may be gathered from it with regard to the progress of science.

One reflection which occurs is, that both Galileo's behaviour and that of his judges, appear to disclose some Italian traits of character. The assumption of supreme authority in all matters of opinion, an assumption unsuited to the powers and condition of man, had led, it would seem, to a kind of artificial state of compromise, in which men's published

opinions were treated as a point of decorum only, the truth being left out of consideration. Thus Galileo seems to have expected that the flimsiest veil of professed submission in his belief would enable his arguments in favour of the Copernican doctrine to pass unvisited; and the inquisitors were satisfied with a renunciation which they could not believe to be sincere. This artificial state, again, was probably one occasion of the furtive mode of insinuating his doctrines, so much employed by Galileo, which some of his historians admire as subtle irony, and others blame as insincerity. Nor do we see anything to lead us to believe that Galileo was not at all times ready to make such submissions as the spiritual tribunals required; although undoubtedly he was also very desirous of promoting the cause of what he conceived to be philosophical truth. The same absence of earnestness appears on the other side, in the courtesy and indulgence with which, as is now almost universally allowed, Galileo was treated throughout the course of the proceedings against him. For his being confined in the dungeons of the Inquisition, as his lot has sometimes been described, appears to have consisted principally in his being placed under some slight restrictions, first, in the house of Nicolini, the ambassador of his own sovereign, the Duke of Tuscany, and afterwards in the country-seat of Archbishop Piccolomini, one

of his own warmest friends. It appears to be not going too far to suppose that the extravagant assumptions of the church of Rome, which it was impossible sincerely to allow, and necessary to evade by artifice, generated in the philosophers of Italy an acuteness and subtlety, but also a suppleness and servility very different from the vigorous independent habits of thought of Germany and England.

But there remains something more to be attended to in the case of Galileo; for though the See of Rome might exaggerate the claims of religious authority, there is a question of no small real difficulty, which the progress of science often brings into notice, as it did then. The revelation on which our religion is founded, seems to declare, or to take for granted, opinions on points on which science also gives her decision; and we then come to this dilemma,—that doctrines, established by a scientific use of reason, may seem to contradict the declarations of revelation according to our view of its meaning;—and yet, that we cannot, in consistency with our religious views, make reason a judge of the truth of revealed doctrines. In the case of astronomy, on which Galileo was called in question, the general sense of cultivated and sober-minded men has long ago drawn the distinction between religious and physical tenets which is necessary to resolve this dilemma. On this point, it is reasonably held,

that the phrases which are employed in Scripture respecting astronomical facts, are not to be made use of to guide our scientific opinions; they may be supposed to answer their end if they fall in with common notions, and are thus effectually subservient to the moral and religious import of revelation. But the establishment of this distinction was not accomplished without long and distressing controversies. Nor, if we wish to include all cases in which the same dilemma may again come into play, is it easy to lay down an adequate canon for the purpose. For we can hardly foresee, beforehand, what part of the past history of the universe may eventually be found to come within the domain of science; or what bearing the tenets, which science establishes, may have upon our view of the providential and revealed government of the world. But without attempting here to generalise on this subject, there are two reflections which may be worth our notice: they are supported by what took place in reference to astronomy on the occasion of which we are speaking; and may, at other periods, be applicable to other sciences.

In the first place, the meaning which any generation puts upon the phrases of Scripture, depends, more than is at first sight supposed, upon the received philosophy of the time. Hence, while men imagine that they are contending for revelation,

they are, in fact, contending for their own interpretation of revelation, unconsciously adapted to what they believe to be rationally probable. And the new interpretation, which the new philosophy requires, and which appears to the older school to be a fatal violence done to the authority of religion, is accepted by their successors without the dangerous results which were apprehended. When the language of Scripture, invested with its new meaning, has become familiar to men, it is found that the ideas which it calls up, are quite as reconcileable as the former ones were, with the soundest religious views. And the world then looks back with surprise at the error of those who thought that the essence of revelation was involved in their own arbitrary version of some collateral circumstance. At the present day we can hardly conceive how reasonable men should have imagined that religious reflections on the stability of the earth, and the beauty and use of the luminaries which revolve round it, would be interfered with by its being acknowledged that this rest and motion are apparent only.

In the next place, we may observe that those who thus adhere tenaciously to the traditionary or arbitrary mode of understanding Scriptural expressions of physical events, are always strongly condemned by succeeding generations. They are looked

upon with contempt by the world at large, who cannot enter into the obsolete difficulties with which they encumbered themselves; and with pity by the more considerate and serious, who know how much sagacity and right-mindedness are requisite for the conduct of philosophers and religious men on such occasions; but who know also how weak and vain is the attempt to get rid of the difficulty by merely denouncing the new tenets as inconsistent with religious belief, and by visiting the promulgators of them with severity such as the state of opinions and institutions may allow. The prosecutors of Galileo are still held up to the scorn and aversion of mankind; although, as we have seen, they did not act till it seemed that their position compelled them to do so, and then proceeded with all the gentleness and moderation which were compatible with judicial forms.

THE NEBULAR HYPOTHESIS.

[*Laplace has proved that the state of the solar system is *stable:* that is, the ellipses which the planets describe will always remain nearly circular, and the axis of revolution of the earth will never deviate much from its present position. He has

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* *Bridgewater Treatise.* Book II. Chap. iii.

shown also that this stability depends on the fact that the planets all move in the same direction, in orbits of small excentricity, and slightly inclined to each other. He has moreover given a mathematical proof that this fact is not accidental. Hence we may regard this arrangement as the result of design, and as intended to secure the stability of the system.]

*We have referred to Laplace, as a profound mathematician, who has strongly expressed the opinion, that the arrangement by which the stability of the solar system is secured is not the result of chance; that "*a primitive cause* has directed the planetary motions." This author, however, having arrived, as we have done, at this conviction, does not draw from it the conclusion which has appeared to us so irresistible, that "the admirable arrangement of the solar system cannot but be the work of an intelligent and most powerful being." He quotes these expressions, which are those of Newton, and points at them as instances where that great philosopher had deviated from the method of true philosophy. He himself proposes an hypothesis concerning the nature of the *primitive cause* of which he conceives the existence to be thus probable: and this hypo-

* *Bridgewater Treatise.* Book II. Chap. vii.

thesis, on account of the facts which it attempts to combine, the view of the universe which it presents, and the eminence of the person by whom it is propounded, deserves our notice.

1. Laplace conjectures that in the original condition of the solar system, the sun revolved upon his axis, surrounded by an atmosphere which, in virtue of an excessive heat, extended far beyond the orbits of all the planets, the planets as yet having no existence. The heat gradually diminished, and as the solar atmosphere contracted by cooling, the rapidity of its rotation increased by the laws of rotatory motion, and an exterior zone of vapour was detached from the rest, the central attraction being no longer able to overcome the increased centrifugal force. This zone of vapour might in some cases retain its form, as we see it in Saturn's ring; but more usually the ring of vapour would break into several masses, and these would generally coalesce into one mass, which would revolve about the sun. Such portions of the solar atmosphere, abandoned successively at different distances, would form "planets in the state of vapour." These masses of vapour, it appears from mechanical considerations, would have each its rotatory motion, and as the cooling of the vapour still went on, would each produce a planet, which might have satellites and rings, formed from the planet in the same manner

as the planets were formed from the atmosphere of the sun.

It may easily be conceived that all the primary motions of a system so produced would be nearly circular, nearly in the plane of the original equator of the solar rotation, and in the direction of that rotation. Reasons are offered also to show that the motions of the satellites thus produced and the motions of rotation of the planets must be in the same direction. And thus it is held that the hypothesis accounts for the most remarkable circumstances in the structure of the solar system: namely, the motions of the planets in the same direction, and almost in the same plane; the motions of the satellites in the same direction as those of the planets; the motions of rotation of these different bodies still in the same direction as the other motions, and in planes not much different; the small excentricity of the orbits of the planets, upon which condition, along with some of the preceding ones, the stability of the system depends; and the position of the source of light and heat in the center of the system.

It is not necessary for the purpose, nor suitable to the plan of the present treatise, to examine, on physical grounds, the probability of the above hypothesis. It is proposed by its author, with great diffidence, as a conjecture only. We might, there-

fore, very reasonably put off all discussion of the bearings of this opinion upon our views of the government of the world, till the opinion itself should have assumed a less indistinct and precarious form. It can be no charge against our doctrines, that there is a difficulty in reconciling with them arbitrary guesses and half-formed theories. We shall, however, make a few observations upon this *nebular hypothesis*, as it may be termed.

2. If we grant, for a moment, the hypothesis, it by no means proves that the solar system was formed without the intervention of intelligence and design. It only transfers our view of the skill exercised, and the means employed, to another part of the work. For, how came the sun and its atmosphere to have such materials, such motions, such a constitution, that these consequences followed from their primordial condition? How came the parent vapour thus to be capable of coherence, separation, contraction, solidification? How came the laws of its motion, attraction, repulsion, condensation, to be so fixed, as to lead to a beautiful and harmonious system in the end? How came it to be neither too fluid nor too tenacious, to contract neither too quickly nor too slowly, for the successive formation of the several planetary bodies? How came that substance, which at one time was a luminous vapour, to be at a subsequent period, solids and fluids of

many various kinds? What but design and intelligence prepared and tempered this previously existing element, so that it should by its natural changes produce such an orderly system?

And if in this way we suppose a planet to be produced, what sort of a body would it be?—something, it may be presumed, resembling a large meteoric stone. How comes this mass to be covered with motion and organization, with life and happiness? What primitive cause stocked it with plants and animals, and produced all the wonderful and subtle contrivances which we find in their structure, all the wide and profound mutual dependences which we trace in their economy? Was man, with his thought and feeling, his powers and hopes, his will and conscience, also produced as an ultimate result of the condensation of the solar atmosphere? Except we allow a prior purpose and intelligence presiding over this material "primitive cause," how irreconcilable is it with the evidence which crowds in upon us on every side!

3. In the next place, we may observe concerning this hypothesis, that it carries us back to the beginning of the present system of things; but that it is impossible for our reason to stop at the point thus presented to it. The sun, the earth, the planets, the moons were brought into their present order out of a previous state, and, as is supposed in

the theory, by the natural operation of laws. But how came that previous state to exist? We are compelled to suppose that it, in like manner, was educed from a still prior state of things; and this, again, must have been the result of a condition prior still. Nor is it possible for us to find, in the tenets of the nebular hypothesis, any restingplace or satisfaction for the mind. The same reasoning faculty, which seeks for the origin of the present system of things, and is capable of assenting to, or dissenting from the hypothesis propounded by Laplace as an answer to this inquiry, is necessarily led to seek, in the same manner, for the origin of any previous system of things, out of which the present may appear to have grown: and must pursue this train of enquiries unremittingly, so long as the answer which it receives describes a mere assemblage of matter and motion; since it would be to contradict the laws of matter and the nature of motion, to suppose such an assemblage to be the *first* condition.

The reflection just stated, may be illustrated by the further consideration of the Nebular Hypothesis. This opinion refers us, for the origin of the solar system, to a sun surrounded with an atmosphere of enormously elevated temperature, revolving and cooling. But as we ascend to a still earlier period, what state of things are we to suppose?—a still higher temperature, a still more diffused

atmosphere. Laplace conceives that, in its primitive state, the sun consisted in a diffused luminosity so as to resemble those nebulæ among the fixed stars, which are seen by the aid of the telescope, and which exhibit a nucleus, more or less brilliant, surrounded by a cloudy brightness. "This anterior state was itself preceded by other states, in which the nebulous matter was more and more diffuse, the nucleus being less and less luminous. We arrive," Laplace says, "in this manner, at a nebulosity so diffuse, that its existence could scarcely be suspected."

"Such is," he adds, "in fact, the first state of the nebulæ which Herschel carefully observed by means of his powerful telescopes. He traced the progress of condensation, not indeed on one nebula, for this progress can only become perceptible to us in the course of centuries; but in the assemblage of nebulæ; much in the same manner as in a large forest we may trace the growth of trees among the examples of different ages which stand side by side. He saw in the first place the nebulous matter dispersed in patches, in the different parts of the sky. He saw in some of these patches this matter feebly condensed round one or more faint nuclei. In other nebulæ, these nuclei were brighter in proportion to the surrounding nebulosity; when by a further condensation the atmosphere of each nucleus becomes

separate from the others, the result is multiple nebulous stars, formed by brilliant nuclei very near each other, and each surrounded by an atmosphere: sometimes the nebulous matter condensing in a uniform manner has produced nebulous systems which are called *planetary*. Finally, a still greater degree of condensation transforms all these nebulous systems into stars. The nebulæ, classed according to this philosophical view, indicate with extreme probability their future transformation into stars, and the anterior nebulous condition of the stars which now exist."

It appears then that the highest point to which this series of conjectures can conduct us, is "an extremely diffused nebulosity," attended, we may suppose, by a far higher degree of heat, than that which, at a later period of the hypothetical process, keeps all the materials of our earth and planets in a state of vapour. Now is it not impossible to avoid asking, whence was this light, this heat, this diffusion? How came the laws which such a state implies, to be already in existence? Whether light and heat produce their effects by means of fluid vehicles or otherwise, they have complex and varied laws which indicate the existence of some subtle machinery for their action. When and how was this machinery constructed? Whence too that enormous expansive power which the nebulous matter

is supposed to possess? And if, as would seem to be supposed in this doctrine, all the material ingredients of the earth existed in this diffuse nebulosity, either in the state of vapour, or in some state of still greater expansion, whence were they and their properties? how came there to be of each simple substance which now enters into the composition of the universe, just so much and no more? Do we not, far more than ever, require an origin of this origin? an explanation of this explanation? Whatever may be the merits of the opinion as a physical hypothesis, with which we do not here meddle, can it for a moment prevent our looking beyond the hypothesis, to a First Cause, an Intelligent Author, an origin proceeding from free volition, not from material necessity?

But again: let us ascend to the highest point of the hypothetical progression: let us suppose the nebulosity diffused throughout all space, so that its course of running into patches is not yet begun. How are we to suppose it distributed? Is it equably diffused in every part? clearly not; for if it were, what should cause it to gather into masses, so various in size, form and arrangement? The separation of the nebulous matter into distinct nebulæ implies necessarily some original inequality of distribution; some determining circumstances in its primitive condition. Whence were these circum-

stances? this inequality? we are still compelled to seek some ulterior agency and power.

Why must the primeval condition be one of change at all? Why should not the nebulous matter be equably diffused throughout space, and continue for ever in its state of equable diffusion, as it must do, from the absence of all cause to determine the time and manner of its separation? why should this nebulous matter grow cooler and cooler? why should it not retain for ever the same degree of heat, whatever heat be? If heat be a fluid, if to cool be to part with its fluid, as many philosophers suppose, what becomes of the fluid heat of the nebulous matter, as the matter cools down? Into what unoccupied region does it find its way?

Innumerable questions of the same kind might be asked, and the conclusion to be drawn is, that every new physical theory which we include in our view of the universe, involves us in new difficulties and perplexities, if we try to erect it into an ultimate and final account of the existence and arrangement of the world in which we live. With the evidence of such theories, considered as scientific generalizations of ascertained facts, with their claims to a place in our natural philosophy, we have here nothing to do. But if they are put forwards as a disclosure of the ultimate cause of that which occurs, and as superseding the necessity of looking further

or higher; if they claim a place in our Natural Theology, as well as our Natural Philosophy; we conceive that their pretensions will not bear a moment's examination.

Leaving then to other persons and to future ages to decide upon the scientific merits of the nebular hypothesis, we conceive that the final fate of this opinion can not, in sound reason, affect at all the view which we have been endeavouring to illustrate; —the view of the universe as the work of a wise and good Creator. Let it be supposed that the point to which this hypothesis leads us, is the ultimate point of physical science; that the farthest glimpse we can obtain of the material universe by our natural faculties, shows it to us occupied by a boundless abyss of luminous matter; still we ask, how space came to be thus occupied, how matter came to be thus luminous? If we establish by physical proofs, that the first fact which can be traced in the history of the world, is that "there was light;" we shall still be led, even by our natural reason, to suppose that before this could occur, "God said, Let there be light."

PHYSIOLOGY.

RECOGNITION OF FINAL CAUSES IN PHYSIOLOGY.

*THERE is one idea which the researches of the physiologist and the anatomist so constantly force upon him, that he cannot help assuming it as one of the guides of his speculations; I mean, the idea of a *purpose*, or, as it is called in Aristotelian phrase, a *final cause*, in the arrangements of the animal frame. It is impossible to doubt that the motive nerves run along the limbs, *in order* that they may convey to the muscles the impulses of the will; and that the muscles are attached to the bones, *in order* that they may move and support them. This conviction prevails so steadily among anatomists, that even when the use of any part is altogether unknown, it is still taken for granted that it has some use. The developement of this conviction,—of a purpose in the parts of animals,—of a function to which each portion of the organization is subservient,—contributed greatly to the progress of physiology; for it constantly urged men forwards in their researches respecting each organ, till some definite view of its purpose was obtained.

* *History of the Inductive Sciences.* Book XVII. Chap. i. Sect. 2.

The assumption of hypothetical final causes in physics may have been, as Bacon asserts it to have been, prejudicial to science; but the assumption of unknown final causes in physiology, has given rise to the science. The two branches of speculation, Physics and Physiology, were equally led, by every new phenomenon, to ask their question, "Why?" But, in the former case, "why" meant "through what cause?" in the latter, "for what end?" And though it may be possible to introduce into physiology the doctrine of efficient causes, such a step can never obliterate the obligations which the science owes to the pervading conception of a purpose contained in all organization.

This conception makes its appearance very early. Indeed, without any special study of our structure, the thought, that we are fearfully and wonderfully made, forces itself upon men, with a mysterious impressiveness, as a suggestion of our Maker. In this bearing, the thought is developed to a considerable extent in the well-known passage in Xenophon's Conversations of Socrates. Nor did it ever lose its hold on sober-minded and instructed men. The Epicureans, indeed, held that the eye was not made for seeing, nor the ear for hearing; and Asclepiades, whom we have already mentioned as an impudent pretender, adopted this wild dogma. Such assertions required no labour. "It is easy,"

says Galen, "for people like Asclepiades, when they come to any difficulty, to say that nature has worked to no purpose." The great anatomist himself pursues his subject in a very different temper. In a well-known passage, he breaks out into an enthusiastic scorn of the folly of the atheistical notions. "Try," he says, "if you can imagine a shoe made with half the skill which appears in the skin of the foot." Some one had spoken of a structure of the human body which he would have preferred to that which it now has. "See," Galen exclaims, after pointing out the absurdity of the imaginary scheme, "see what brutishness there is in this wish. But if I were to spend more words on such cattle, reasonable men might blame me for desecrating my work, which I regard as a religious hymn in honour of the Creator."

THE PLANS OF ANIMAL FORMS.

*Animals were divided by Lamarck into vertebrate and invertebrate; and the general analogies of all vertebrate animals are easily made manifest. But with regard to other animals, the point is far from clear. Cuvier was the first to give a really philosophical view of the animal world in reference to the plan on which each animal is constructed.

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* *History of the Inductive Sciences.* Book XVII. Chap. vii. Sect. 2, 3.

There are*, he says, four such plans;—four forms on which animals appear to have been modelled; and of which the ulterior divisions, with whatever titles naturalists have decorated them, are only very slight modifications, founded on the developement or addition of some parts which do not produce any essential change in the plan.

The four great branches of the animal world are the *vertebrata*, *mollusca*, *articulata*, *radiata;* and the differences of these are so important that a slight explanation of them may be permitted.

The *vertebrata* are those animals which (as man and other sucklers, birds, fishes, lizards, frogs, serpents,) have a back-bone and a skull with lateral appendages, within which the viscera are included, and to which the muscles are attached.

The *mollusca*, or soft animals, have no bony skeleton; the muscles are attached to the skin, which often includes stony plates called shells; such molluscs are shell-fish, others are cuttle-fish, and many pulpy sea-animals.

The *articulata* consist of *crustacea*, (lobsters, &c.,) *insects*, *spiders*, and *annulose worms*, which, like the other classes of this branch, consist of a head and a number of successive portions of the body jointed together, whence the name.

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* *Règne Animal*, p. 57.

Finally, the *radiata* include the animals known under the name of *zoophytes*. In the preceding three branches, the organs of motion and of sense were distributed symmetrically on the two sides of an axis, so that the animal has a right and a left side. In the radiata the similar members radiate from the axis in a circular manner, like the petals of a regular flower.

The whole value of such a classification cannot be understood without explaining its use in enabling us to give general descriptions, and general laws of the animal functions, of the classes which it includes; but in the present part of our work our business is to exhibit it as an exemplification of the reduction of animals to laws of symmetry. The bipartite symmetry of the form of vertebrate and articulate animals is obvious; and the reduction of the various forms of such animals to a common type has been effected, by attention to their anatomy, in a manner which has satisfied those who have best studied the subject. The molluscs, especially those in which the head disappears, as oysters, or those which are rolled into a spiral, as snails, have a less obvious symmetry, but here also we can apply certain general types. And the symmetry of the radiated zoophytes is of a nature quite different from all the rest, and approaching, as we have suggested, to the kind of sym-

metry found in plants. Some naturalists have doubted whether* these zoophytes are not referrible to two types (*acrita* or polypes, and true *radiata*), rather than to one.

Supposing this great step in Zoology, of which we have given an account,—the reduction of all animals to four types or plans,—to be quite secure, we are then led to ask whether any further advance is possible;—whether several of these types can be referred to one common form by any wider effort of generalisation. On this question there has been a considerable difference of opinion. Geoffroy Saint-Hilaire†, who had previously endeavoured to show that all vertebrate animals were constructed so exactly upon the same plan as to preserve the strictest analogy of parts in respect to their osteology, thought to extend this unity of plan by demonstrating, that the hard parts of crustaces and insects are still only modifications of the skeleton of higher animals, and that therefore the type of vertebrata must be made to include them also:—the segments of the articulata are held to be strictly analogous to the vertebræ of the higher animals, and thus the former live *within* their vertebral column in the same manner as the latter live *without* it. Attempts have even been made to reduce molluscous and vertebrate

* *Brit. Assoc. Rep.* iv. 227. † Mr. Jenyns, Ibid. iv. 150.

animals to a community of type, as we shall see shortly.

Another application of the principle, according to which creatures the most different are developements of the same original type, may be discerned* in the doctrine, that the embryo of the higher forms of animal life passes by gradations through those forms which are permanent in inferior animals. Thus, according to this view, the human fœtus assumes successively, the plan of the zoophyte, the worm, the fish, the turtle, the bird, the beast. But it has been well observed, that "in these analogies we look in vain for the precision which can alone support the inference that has been deduced†;" and that at each step, the higher embryo and the lower animal which it is supposed to resemble, differ in having each different organs suited to their respective destinations.

Cuvier‡ never assented to this view, nor to the attempts to refer the different divisions of his system to a common type. "He could not admit," says his biographer, "that the lungs or gills of the vertebrates are in the same connexion as the branchiæ of molluscs and crustaces, which in the one are situated at the base of the feet, or fixed on the feet them-

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* Dr. Clark, *Brit. Assoc. Report*, iv. 113. † Dr. Clark, p. 114.
‡ Laurillard, *Elog. de Cuvier*, p. 66.

selves, and in the other often on the back or about the arms. He did not admit the analogy between the skeleton of the vertebrates and the skin of the articulates; he could not believe that the tenia and the sepia were constructed on the same plan; that there was a similarity of composition between the bird and the echinus, the whale and the snail; in spite of the skill with which some persons sought gradually to efface their discrepancies."

Whether it may be possible to establish, among the four great divisions of the "Animal Kingdom," some analogies of a higher order than those which prevail within each division, I do not pretend to conjecture. If this can be done, it is clear that it must be by comparing the types of these divisions under their most general forms: and thus Cuvier's arrangement, so far as it is itself rightly founded on the unity of composition of each branch, is the surest step to the discovery of a unity pervading and uniting these branches. But though those who generalise surely, and those who generalise rapidly, may travel in the same direction, they soon separate so widely, that they appear to move from each other. The partisans of a universal "unity of composition" of animals, accused Cuvier of being too inert in following the progress of physiological and zoological science. Borrowing their illustration from the political parties of the times, they asserted that he

belonged to the science of the *resistance*, not to the science of the *movement*. Such a charge is highly honourable to him; for no one acquainted with the history of zoology can doubt that he had a great share in the impulse by which the "movement" was occasioned; or that he himself made a large advance with it; and it was because he was so poised by the vast mass of his knowledge, so temperate in his love of doubtful generalisations, that he was not swept on in the wilder part of the stream. To such a charge, moderate reformers, who appreciate the value of the good which exists, though they try to make it better, and who know the knowledge, thoughtfulness, and caution, which are needful in such a task, are naturally exposed. For us, who can only decide on such a subject by the general analogies of the history of science, it may suffice to say, that it appears doubtful whether the fundamental conceptions of affinity, analogy, transition, and developement, have yet been fixed in the minds of physiologists with sufficient firmness and clearness, or unfolded with sufficient consistency and generality, to make it likely that any great additional step of this kind can for some time be made.

USE OF FINAL CAUSES IN PHYSIOLOGY.

Doctrine of Unity of Plan.—We have repeatedly seen, in the course of our historical view of physiology, that those who have studied the structure of animals and plants, have had a conviction forced upon them, that the organs are constructed and combined in subservience to the life and functions of the whole. The parts have a purpose, as well as a law;—we can trace final causes, as well as laws of causation. This principle is peculiar to physiology; and it might naturally be expected that, in the progress of the science, it would come under special consideration. This accordingly has happened; and the principle has been drawn into a prominent position by the struggle of two antagonist schools of physiologists. On the one hand, it has been maintained that this doctrine of final causes is altogether unphilosophical, and requires to be replaced by a more comprehensive and profound principle: on the other hand, it is asserted that the doctrine is not only true, but that, in our own time, it has been fixed and developed so as to become the instrument of some of the most important discoveries which have been made. Of the views of these two schools we must endeavour to give some account.

The disciples of the former of the two schools express their tenets by the phrases *unity* of *plan*,

unity of *composition;* and the more detailed developement of these doctrines has been termed the *Theory of Analogues*, by Geoffroy Saint-Hilaire, who claims this theory as his own creation. According to this theory, the structure and functions of animals are to be studied by the guide of their analogy only; our attention is to be turned, not to the fitness of the organization for any end of life or action, but to its resemblance to other organizations by which it is gradually derived from the original type.

According to the rival view of this subject, we must not assume, and cannot establish, that the plan of all animals is the same, or their composition similar. The existence of a single and universal system of analogies in the construction of all animals is entirely unproved, and therefore cannot be made our guide in the study of their properties. On the other hand, the plan of the animal, the purpose of its organization in the support of its life, the necessity of the functions to its existence, are truths which are irresistibly apparent, and which may therefore be safely taken as the bases of our reasonings. This view has been put forwards as the doctrine of the *conditions of existence:* it may also be described as the principle of *a purpose in organization;* the structure being considered as having the function for its end. We must say a few words on each of these views.

It had been pointed out by Cuvier, as we have seen in the last chapter, that the animal kingdom may be divided into four great branches; in each of which the *plan* of the animal is different, namely, *vertebrata*, *articulata*, *mollusca*, *radiata*. Now the question naturally occurs, is there really no resemblance of construction in these different classes? It was maintained by some, that there is such a resemblance. In 1820*, M. Audouin, a young naturalist of Paris, endeavoured to fill up the chasm which separates insects from other animals; and by examining carefully the portions which compose the solid frame-work of insects, and following them through their various transformations in different classes, he conceived that he found relations of position and function, and often of number and form, which might be compared with the relations of the parts of the skeleton in vertebrate animals. He thought that the first segment of an insect, the head†, represents one of the three vertebræ which, according to Spix and others, compose the vertebrate head: the second segment of the insects, (the *prothorax* of Audouin,) is, according to M. Geoffroy, the second vertebra of the head of the vertebrata, and so on. Upon this speculation Cuvier‡ does not give any decided opinion; observing only, that

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* Cuv. *Hist. Sc. Nat.* III. 422. † Ibid. 437. ‡ Ibid. 441.

even if false, it leads to active thought and useful research.

But when an attempt was further made to identify the plan of another branch of the animal world, the mollusca, with that of the vertebrata, the radical opposition between such views and those of Cuvier, broke out into an animated controversy.

Two French anatomists, MM. Laurencet and Meyranx, presented to the Academy of Sciences, in 1830, a Memoir containing their views on the organization of molluscous animals; and on the sepia or cuttle-fish in particular, as one of the most complete examples of such animals. These creatures, indeed, though thus placed in the same division with shell-fish of the most defective organization and obscure structure, are far from being scantily organized. They have a brain*, often eyes, and these, in the animals of this class, (*cephalopoda*) are more complicated than in any vertebrates†; they have sometimes ears, salivary glands, multiple stomachs, a considerable liver, a bile, a complete double circulation provided with auricles and ventricles; in short, their vital activity is vigorous, and their senses are distinct.

But still, though this organization, in the abun-

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* Geoffroy Saint-Hilaire denies this. *Principes de Phil. Zoologique discutés en* 1830, p. 68.

† Ibid. p. 55.

dance and diversity of its parts, approaches that of vertebrate animals, it had not been considered as composed in the same manner, or arranged in the same order. Cuvier had always maintained that the plan of molluscs is not a continuation of the plan of vertebrates.

MM. Laurencet and Meyranx, on the contrary, conceived that the sepia might be reduced to the type of a vertebrate creature, by considering the back-bone of the latter bent double backwards, so as to bring the root of the tail to the nape of the neck; the parts thus brought into contact being supposed to coalesce. By this mode of conception, these anatomists held that the viscera were placed in the same connexion as in the vertebrate type, and the functions exercised in an analogous manner.

To decide on the reality of the analogy thus asserted, clearly belonged to the jurisdiction of the most eminent anatomists and physiologists. The Memoir was committed to Geoffroy Saint-Hilaire and Latreille, two eminent zoologists, in order to be reported on. Their report was extremely favourable; and went almost to the length of adopting the views of the authors.

Cuvier expressed some dissatisfaction with this report on its being read*; and a short time after-

* *Phil. Zool.* p. 36.

wards*, represented Geoffroy Saint-Hilaire as having asserted that the new views of Laurencet and Meyranx refuted completely the notion of the great interval which exists between molluscous and vertebrate animals. Geoffroy protested against such an interpretation of his expressions; but it soon appeared, by the controversial character which the discussions on this and several other subjects assumed, that a real opposition of opinions was in action.

Without attempting to explain the exact views of Geoffroy, (we may, perhaps, venture to say that they are hardly yet generally understood with sufficient distinctness to justify the mere historian of science in attempting such an explanation,) their general tendency may be sufficiently collected from what has been said; and from the phrases in which his views are conveyed†. *The principle of connexions, the elective affinities of organic elements, the equilibrization of organs;*—such are the designations of the leading doctrines which are unfolded in the preliminary discourse of his *Anatomical Philosophy*. Elective affinities of organic elements are the forces by which the vital structures and varied forms of living things are produced; and the principles of connexion and equilibrium of these forces in the various parts of the organization, prescribe limits and conditions to the variety and developement of such forms.

* *Phil. Zool.* p. 50. † Ibid. p. 15.

The character and tendency of this philosophy will be, I think, much more clear, if we consider what it excludes and denies. It rejects altogether all conception of a plan and purpose in the organs of animals, as a principle which has determined their forms, or can be of use in directing our reasonings. "I take care," says Geoffroy*, "not to ascribe to God any intention." And when Cuvier speaks of the combination of organs in such order that they may be in consistence with the part which the animal *has to play* in nature; his rival rejoins†, "I know nothing of animals which *have to play* a part in nature." Such a notion is, he holds, unphilosophical and dangerous. It is an abuse of final causes which makes the cause to be engendered by the effect. And to illustrate still further his own view, he says, "I have read concerning fishes, that because they live in a medium which resists more than air, their motive forces are calculated so as to give them the power of progression under those circumstances. By this mode of reasoning, you would say of a man who makes use of crutches, that he was originally destined to the misfortune of having a leg paralyzed or amputated."

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* "Je me garde de prêter à Dieu aucune intention." *Phil. Zool.* p. 10.

† "Je ne connais point d'animal qui DOIVE jouer un rôle dans la nature." p. 65.

How far this doctrine of unity in the plan in animals is admissible or probable in physiology when kept within proper limits, that is, when not put in opposition to the doctrine of a purpose involved in the plan of animals, I do not pretend even to conjecture. The question is one which appears to be at present deeply occupying the minds of the most learned and profound physiologists; and such persons alone, adding to their knowledge and zeal, judicial sagacity and impartiality, can tell us what is the general tendency of the best researches on this subject*. But when the anatomist expresses such opinions, and defends them by such illustrations as those which I have just quoted†, we perceive that he quits the entrenchments of his superior science, in which he might have remained unassailable so long as the question was a professional one; and the discussion is open to those who possess no peculiar knowledge of anatomy. We shall, therefore, venture to say a few words upon it.

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* So far as this doctrine is generally accepted among the best physiologists, we cannot doubt the propriety of Meckel's remarks, (*Comparative Anatomy*, 1821, Pref. p. xi.) that it cannot be truly asserted either to be new, or to be peculiarly due to Geoffroy Saint-Hilaire.

† It is hardly worth while answering such illustrations, but I may remark, that the one quoted above, irrelevant and unbecoming as it is, tells altogether against its author. The fact that the wooden leg is of the same length as the other, proves, and would satisfy the most incredulous man, that it was *intended* for walking.

Estimate of this Doctrine.—It has been so often repeated, and so generally allowed in modern times, that final causes ought not to be made our guides in natural philosophy, that a prejudice has been established against the introduction of any views to which this designation can be applied, into physical speculations. Yet, in fact, the assumption of an end or purpose in the structure of organized beings, appears to be an intellectual habit which no efforts can cast off. It has prevailed from the earliest to the latest ages of zoological research; appears to be fastened upon us alike by our ignorance and our knowledge; and has been formally accepted by so many great anatomists, that we cannot feel any scruple in believing the rejection of it to be a superstition of a false philosophy, and a result of the exaggeration of other principles which are supposed capable of superseding its use. And the doctrine of unity of plan of all animals, and the other principles associated with this doctrine, so far as they exclude the conviction of an intelligible scheme and a discoverable end, in the organization of animals, appear to be utterly erroneous. I will offer a few reasons for an opinion which may appear presumptuous in a writer who has only a general knowledge of the subject.

1. In the first place, it appears to me that the argumentation on the case in question, the sepia,

does by no means turn out to the advantage of the new hypothesis. The arguments in support of the hypothetical view of the structure of this mollusc were, that by this view the relative position of the parts was explained, and conformations which had appeared altogether anomalous, were reduced to rule; for example, the beak, which had been supposed to be in a position the reverse of all other beaks, was shown, by the assumed posture, to have its upper mandible longer than the lower, and thus to be regularly placed. "But," says Cuvier*, "supposing the posture, in order that the side on which the funnel of the sepia is folded should be the back of the animal, considered as similar to a vertebrate, the brain with regard to the beak, and the œsophagus with regard to the liver, should have positions corresponding to those in vertebrates; but the positions of these organs are exactly contrary to the hypothesis. How, then, can you say," he asks, "that the cephalopods and vertebrates have *identity of composition*, *unity of composition*, without using words in a sense entirely different from their common meaning?"

This argument appears to be exactly of the kind on which the value of the hypothesis must depend†.

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* G. S. H. *Phil. Zool.* p. 70.

† I do not dwell on other arguments which were employed. It was given as a circumstance suggesting the supposed posture of the

It is, therefore, interesting to see the reply made to it by the theorist. It is this: "I admit the facts here stated, but I deny that they lead to the notion of a different sort of animal composition. Molluscous animals had been placed too high in the zoological scale; but if they are only the embryos of its lower stages, if they are only beings in which far fewer organs come into play, it does not follow that the organs are destitute of the relations which the power of successive generations may demand. The organ A will be in an unusual relation with the organ C, if B has not been produced;—if a stoppage of the developement has fallen upon this latter organ, and has thus prevented its production. And thus," he says, "we see how we may have different arrangements, and diverse constructions as they appear to the eye."

It seems to me that such a concession as this entirely destroys the theory which it attempts to defend; for what arrangement does the principle of unity of composition *exclude*, if it admits unusual, that is, various arrangements of some organs, ac-

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type, that in this way the back was coloured, and the belly was white. On this Cuvier observes, (*Phil. Zool.* p. 39, 68.) "I must say, that I do not know any naturalist so ignorant as to suppose that the back is determined by its dark colour, or even by its position when the animal is in motion; they all know that the badger has a black belly and a white back; that an infinity of other animals, especially among insects, are in the same case; and that many fishes swim on their side, or with their belly upwards."

companied by the total absence of others? Or how does this differ from Cuvier's mode of stating the conclusion, except in the introduction of certain arbitrary hypotheses of developement and stoppage. "I reduce the facts," Cuvier says, "to their true expression, by saying that cephalopods have several organs which are common to them and vertebrates, and which discharge the same offices; but that these organs are in them differently distributed, and often constructed in a different manner; and they are accompanied by several other organs which vertebrates have not; while these on the other hand have several which are wanting in cephalopods."

We shall see afterwards the general principles which Cuvier himself considered as the best guides in these reasonings. But I will first add a few words on the disposition of the school now under consideration, to reject all assumption of an end.

2. That the parts of the bodies of animals are made in order to discharge their respective offices, is a conviction which we cannot believe to be otherwise than an irremovable principle of the philosophy of organization, when we see the manner in which it has constantly forced itself upon the minds of zoologists and anatomists in all ages; not only as an inference, but as a guide whose indications they could not help following. I have already noticed expressions of this conviction in some of the prin-

cipal persons who occur in the history of physiology, as Galen and Harvey. I might add many more, but I will content myself with adducing a contemporary of Geoffroy's, whose testimony is the more remarkable, because he obviously shares with his countryman in the common prejudice against the use of final causes. "I consider," he says, in speaking of the provisions for the reproduction of animals*, "with the great Bacon, the philosophy of final causes as sterile; but I have elsewhere acknowledged that it was very difficult for the most cautious man never to have recourse to them in his explanations." After the survey which we have had to take of the history of physiology, we cannot but see that the assumption of final causes in this branch of science is so far from being sterile, that it has had a large share in every discovery which is included in the existing mass of real knowledge. The use of every organ has been discovered by starting from the assumption that it must have *some* use. The doctrine of the circulation of the blood was, as we have seen, clearly and professedly due to the persuasion of a purpose in the circulatory apparatus. The study of comparative anatomy is the study of the adaptation of animal structures to their purposes. And we shall soon have to shew that this conception

* Cabanis, *Rapports du Physique et du Morale de l'Homme*, I. 299.

of final causes has, in our own times, been so far from barren, that it has, in the hands of Cuvier and others, enabled us to become intimately acquainted with vast departments of zoology to which we have no other mode of access. It has placed before us in a complete state, animals, of which, for thousands of years, only a few fragments have existed, and which differ widely from all existing animals; and it has given birth, or at least has given the greatest part of its importance and interest, to a science which forms one of the brightest parts of the modern progress of knowledge. It is, therefore, very far from being a vague and empty assertion, when we say that final causes are a real and indestructible element in zoological philosophy; and that the exclusion of them, as attempted by the school of which we speak, is a fundamental and most mischievous error.

3. Thus, though the physiologist may persuade himself that he ought not to refer to final causes, we find that, practically, he cannot help it; and that the event shows that his practical habit is right and well-founded. But he may still cling to the speculative difficulties and doubts in which such subjects may be involved by *à priori* considerations. He may say, as Saint-Hilaire does say*, "I ascribe

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* *Phil. Zool.* p. 10.

no intention to God, for I mistrust the feeble powers of my reason. I observe facts merely, and go no further. I only pretend to the character of the historian of *what is*." "I cannot make nature an intelligent being who does nothing in vain, who acts by the shortest mode, who does all for the best."

I am not going to enter at any length into this subject, which, thus considered, is metaphysical and theological, rather than physiological. If any one maintain, as some have maintained, that no manifestation of means apparently used for ends in nature, *can* prove the existence of design in the Author of nature, this is not the place to refute such an opinion in its general form. But I think it may be worth while to show, that even those who incline to such an opinion, still cannot resist the necessity which compels men to assume, in organized beings, the existence of an end.

Among the philosophers who have referred our conviction of the being of God to our moral nature, and have denied the possibility of demonstration on mere physical grounds, Kant is perhaps the most eminent. Yet he has asserted the reality of such a principle of physiology as we are now maintaining in the most emphatic manner. Indeed, this assumption of an end makes his very definition of an organized being. "An organized product of nature is that in which all the parts are mutually ends and

means*." And this, he says, is a universal and necessary maxim. He adds, "It is well known that the anatomisers of plants and animals, in order to investigate their structure, and to obtain an insight into the grounds why and to what end such parts, why such a situation and connexion of the parts, and exactly such an internal form, come before them, assume, as indispensably necessary, this maxim, that in such a creature nothing is *in vain*, and proceed upon it in the same way in which in general natural philosophy we proceed upon the principle that *nothing happens by chance*. In fact, they can as little free themselves from this teleological principle as from the general physical one; for as, on omitting the latter, no experience would be possible, so on omitting the former principle, no clue could exist for the observation of a kind of natural objects which can be considered teleologically under the conception of natural ends."

Even if the reader should not follow the reasoning of this celebrated philosopher, he will still have no difficulty in seeing that he asserts, in the most distinct manner, that which is denied by the author whom we have before quoted, the propriety and necessity of assuming the existence of an end as our guide in the study of animal organization.

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* *Urtheilskraft*, p. 296.

4. It appears to me, therefore, that whether we judge from the arguments, the results, the practice of physiologists, their speculative opinions, or those of the philosophers of a wider field, we are led to the same conviction, that in the organized world we may and must adopt the belief, that organization exists for its purpose, and that the apprehension of the purpose may guide us in seeing the meaning of the organization. And I now proceed to shew how this principle has been brought into additional clearness and use by Cuvier.

In doing this, I may, perhaps, be allowed to make a reflection of a kind somewhat different from the preceding remarks, though suggested by them. In another work*, I endeavoured to shew that those who have been discoverers in science have generally had minds, the disposition of which was to believe in an intelligent Maker of the universe; and that the scientific speculations which produced an opposite tendency, were generally those which, though they might deal familiarly with known physical truths, and conjecture boldly with regard to the unknown, did not add to the number of solid generalisations. In order to judge whether this remark is distinctively applicable in the case now considered, I should have

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* *Bridgewater Treatise*, Book III. Chap. vii. and viii. On Inductive Habits of Thought, and On Deductive Habits of Thought.

to estimate Cuvier in comparison with other physiologists of his time, which I do not presume to do But I may observe, that he is allowed by all to have established, on an indestructible basis, many of the most important generalisations which zoology now contains; and the principal defect which his critics have pointed out, has been, that he did not generalise still more widely and boldly. It appears, therefore, that he cannot but be placed among the great discoverers in the studies which he pursued; and this being the case, those who look with pleasure on the tendency of the thoughts of the greatest men to an Intelligence far higher than their own, must be gratified to find that he was an example of this tendency; and that the acknowledgement of a creative purpose, as well as a creative power, not only entered into his belief, but made an indispensable and prominent part of his philosophy.

Doctrine of Final Causes.—We have now to describe more in detail the doctrine which Cuvier maintained in opposition to such opinions as we have been speaking of; and which, in his way of applying it, we look upon as a material advance in physiological knowledge, and therefore give to it a distinct place in our history. "Zoology has," he says*, in the outset of his Règne Animal, "a prin-

* *Règne An.* p. 6.

ciple of reasoning which is peculiar to it, and which it employs with advantage on many occasions: this is the principle of *the conditions of existence*, vulgarly called the principle of *final causes*. As nothing can exist if it do not combine all the conditions which render its existence possible, the different parts of each being must be co-ordinated in such a manner as to render the total being possible, not only in itself, but in its relations to those which surround it; and the analysis of these conditions often leads to general laws, as clearly demonstrated as those which result from calculation or from experience."

This is the enunciation of his leading principle in general terms. To our ascribing it to him, some may object, on the ground of its being self-evident in its nature*, and having been very anciently applied. But to this we reply, that the principle must be considered as a real discovery, in the hands of him who first shows how to make it an instrument of other discoveries. It is true in other cases as well as in this, that some vague apprehension of true general principles, such as *à priori* considerations can supply, has long preceded the knowledge of them as real and verified laws. In such a way it was seen, before Newton, that the motions of the planets must result from attraction; and before Dufay and

* Swainson, *Study of Nat. Hist.* p. 85.

Franklin, it was held that electrical actions must result from a fluid. Cuvier's merit consisted, not in seeing that an animal cannot exist without combining all the conditions of its existence; but in perceiving that this truth may be taken as a guide in our researches concerning animals;—that the mode of their existence may be collected from one part of their structure, and then applied to interpret or detect another part. He went on the supposition not only that animal forms have *some* plan, *some* purpose, but that they have an intelligible plan, a discoverable purpose. He proceeded in his investigations like the decipherer of a manuscript, who makes out his alphabet from one part of the context, and then applies it to read the rest. The proof that his principle was something very different from an identical proposition, is to be found in the fact, that it enabled him to understand and arrange the structures of animals with unprecedented clearness and completeness of order; and to restore the forms of the extinct animals which are found in the rocks of the earth, in a manner which has been universally assented to as irresistibly convincing. These results cannot flow from a trifling or barren principle; and they show us that if we are disposed to form such a judgment of Cuvier's doctrine, it must be because we do not fully apprehend its import.

To illustrate this, we need only quote the state-

ment which he makes, and the uses to which he applies it. Thus in the Introduction to his great work on "Fossil Remains," he says, "Every organized being forms an entire system of its own, all the parts of which mutually correspond, and concur to produce a certain definite purpose by reciprocal reaction, or by combining to the same end. Hence none of these separate parts can change their forms, without a corresponding change in the other parts of the same animal; and consequently each of these parts, taken separately, indicates all the other parts to which it has belonged. Thus, if the viscera of an animal are so organized as only to be fitted for the digestion of recent flesh, it is also requisite that the jaws should be so constructed as to fit them for devouring prey; the claws must be constructed for seizing and tearing it in pieces; the teeth for cutting and dividing its flesh; the entire system of the limbs or organs of motion for pursuing and overtaking it; and the organs of sense for discovering it at a distance. Nature must also have endowed the brain of the animal with instincts sufficient for concealing itself, and for laying plans to catch its necessary victims*." By such considerations he has been able to reconstruct the whole of

* *Theory of the Earth*, p. 90.

many animals of which parts only were given;—a positive result, which shows both the reality and the value of the truth on which he wrought.

Another great example, equally showing the immense importance of this principle in Cuvier's hands, is the reform which, by means of it, he introduced into the classification of animals. Here again we may quote the view he himself has given* of the character of his own improvements. In studying the physiology of the natural classes of vertebrate animals, he found, he says, "in the respective quantity of their respiration, the reason of the quantity of their motion, and consequently of the kind of locomotion. This, again, furnishes the reason for the forms of their skeletons and muscles; and the energy of their senses, and the force of their digestion, are in a necessary proportion to the same quantity. Thus a division which had till then been established, like that of vegetables, only upon observation, was found to rest upon causes appreciable, and applicable to other cases." Accordingly, he applied this view to invertebrates;—examined the modifications which take place in their organs of circulation, respiration, and sensation; and having calculated the necessary results of these modifica-

* *Hist. Sc. Nat.* 1, 293.

tions, he deduced from it a new division of those animals, in which they are arranged according to their true relations.

Such have been some of the results of the principle of the conditions of existence, as applied by its great assertor.

It is clear, indeed, that such a principle could acquire its practical value only in the hands of a person intimately acquainted with anatomical details, with the functions of the organs, and with their variety in different animals. It is only by means of such nutriment that the embryo truth could be developed into a vast tree of science. But it is not the less clear, that Cuvier's immense knowledge and great powers of thought led to their results, only by being employed under the guidance of this master-principle: and, therefore, we may justly consider it as the distinctive feature of his speculations, and follow it with a gratified eye, as the thread of gold which runs through, connects, and enriches his zoological researches:—gives them a deeper interest and a higher value than can belong to any view of the organical sciences, in which the very essence of organization is kept out of view.

The real philosopher, who knows that all the kinds of truth are intimately connected, and that all the best hopes and encouragements which are granted to our nature must be consistent with truth,

will be satisfied and confirmed, rather than surprised and disturbed, thus to find the natural sciences leading him to the borders of a higher region. To him it will appear natural and reasonable, that, after journeying so long among the beautiful and orderly laws by which the universe is governed, we find ourselves at last approaching to a source of order and law, and intellectual beauty:—that, after venturing into the region of life and feeling and will, we are led to believe the fountain of life and will, not to be itself unintelligent and dead, but to be a living mind, a power which aims as well as acts. To us this doctrine appears like the natural cadence of the tones to which we have so long been listening; and without such a final strain our ears would have been left craving and unsatisfied. We have been lingering long amid the harmonies of law and symmetry, constancy and developement; and these notes, though their music was sweet and deep, must too often have sounded to the ear of our moral nature, as vague and unmeaning melodies, floating in the air arouud us, but conveying no definite thought, moulded into no intelligible announcement. But one passage which we have again and again caught by snatches, though sometimes interrupted and lost, at last swells in our ears full, clear, and decided; and the religious "Hymn in honour of the Creator," to which Galen so gladly

lent his voice, and in which the best physiologists of succeeding times have ever joined, is filled into a richer and deeper harmony by the greatest philosophers of these later days, and will roll on hereafter, the "perpetual song" of the temple of science.

QUESTION OF THE TRANSMUTATION OF SPECIES.

*Besides the fortunes of individual plants and animals, of which the geologist has traces brought under his notice, there is another class of questions, of great interest, but of great difficulty;—the fortunes of each species. In what manner do species which were not, begin to be? as geology teaches us that they many times have done; and, as even our own reasonings convince us they must have done, at least in the case of the species among which we live.

We here obviously place before us, as a subject of research, the creation of living things;—a subject shrouded in mystery, and not to be approached without reverence. But though we may conceive, that, on this subject, we are not to seek our belief from science alone, we shall find, it is asserted, within the limits of allowable and unavoidable speculation, many curious and important problems which

* *Hist. Ind. Sc.* Book XVIII. Chap. vi. Sect. 2, 3, 4.

may well employ our physiological skill. For example, we may ask:—how we are to recognise the species which were originally created distinct?—whether the population of the earth at one geological epoch could pass to the form which it has at a succeeding period, by the agency of natural causes alone?—and if not, what other account we can give of the succession which we find to have taken place?

The most remarkable point in the attempts to answer these and the like questions, is the controversy between the advocates and the opponents of the doctrine of the *transmutation of species*. This question is, even from its mere physiological import, one of great interest; and the interest is much enhanced by our geological researches, which again bring the question before us in a striking form, and on a gigantic scale. We shall, therefore, briefly state the point at issue.

We see that animals and plants may, by the influence of breeding, and of external agents operating upon their constitution, be greatly modified, so as to give rise to varieties and races different from what before existed. How different, for instance, is one kind and breed of dog from another! The question, then, is, whether organized beings can, by the mere working of natural causes, pass from the type of one species to that of another? whether the wolf may, by domestication, become the dog?

whether the ourang-outang may, by the power of external circumstances, be brought within the circle of the human species? And the dilemma in which we are placed is this;—that if species are not thus interchangeable, we must suppose the fluctuations of which each species is capable, and which are apparently indefinite, to be bounded by rigorous limits; whereas, if we allow such a *transmutation of species*, we abandon that belief in the adaptation of the structure of every creature to its destined mode of being, which not only most persons would give up with repugnance, but which, as we have seen, has constantly and irresistibly impressed itself on the minds of the best naturalists, as the true view of the order of the world.

The question, of the limited or unlimited extent of the modifications of animals and plants, has received full and careful consideration from eminent physiologists: and in their opinions we find, I think, an indisputable preponderance to that decision which rejects the transmutation of species, and which accepts the former side of the dilemma; namely, that the changes of which each species is susceptible, though difficult to define in words, are limited in fact. It is extremely interesting and satisfactory thus to receive an answer in which we can confide, to inquiries seemingly so wide and bold as those which this subject involves. I refer

to Mr. Lyell, Dr. Prichard, Mr. Lawrence, and others, for the history of the discussion, and for the grounds of the decision; and I shall quote very briefly the main points and conclusions to which the inquiry has led*.

It may be considered, then, as determined by the over-balance of physiological authority, that there is a capacity in all species to accommodate themselves, to a certain extent, to a change of external circumstances; this extent varying greatly according to the species. There may thus arise changes of appearance or structure, and some of these changes are transmissible to the offspring: but the mutations thus superinduced are governed by constant laws, and confined within certain limits. Indefinite divergence from the original type is not possible; and the extreme limit of possible variation may usually be reached in a short period of time: in short, *species have a real existence in nature*, and a transmutation from one to another does not exist.

Thus, for example, Cuvier remarks†, that notwithstanding all the differences of size, appearance, and habits, which we find in the dogs of various races and countries, and though we have (in the Egyptian mummies) skeletons of this animal as it existed three thousand years ago, the relation of

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* Lyell, B. II. c. iv. † Ossem. *Foss. Disc. Prél.* p. 61.

the bones to each other remains essentially the same; and, with all the varieties of their shape and size, there are characters which resist all the influences both of external nature, of human intercourse, and of time.

HYPOTHESIS OF PROGRESSIVE TENDENCIES.

Within certain limits, however, as we have said, external circumstances produce changes in the forms of organized beings. The causes of change, and the laws and limits of their effects, as they obtain in the existing state of the organic creation, are in the highest degree interesting. And, as has been already intimated, the knowledge thus obtained, has been applied with a view to explain the origin of the existing population of the world, and the succession of its past conditions. But those who have attempted such an explanation, have found it necessary to assume certain additional laws, in order to enable themselves to deduce, from the tenet of the transmutability of the species of organized beings, such a state of things as we see about us, and such a succession of states as is evidenced by geological researches. And here, again, we are brought to questions of which we must seek the answers from the most profound physiologists. Now referring, as before, to those which

appear to be the best authorities, it is found that these additional positive laws are still more inadmissible than the primary assumption of indefinite capacity of change. For example, in order to account, on this hypothesis, for the seeming adaptation of the endowments of animals to their wants, it is held that the endowments are the result of the wants;—that the swiftness of the antelope, the claws and teeth of the lion, the trunk of the elephant, the long neck of the giraffe, have been produced by a certain plastic character in the constitution of animals, operated upon, for a long course of ages, by the attempts which these animals made to attain objects which their previous organization did not place within their reach. In this way, it is maintained that the most striking attributes of animals, those which apparently imply most clearly the providing skill of their Creator, have been brought forth by the long-repeated efforts of the creatures to attain the object of their desires; thus animals with the highest endowments have been gradually developed from ancestral forms of the most limited organization: thus fish, birds, and beasts, have grown from *small gelatinous bodies*, "petits corps gelatineux," possessing some obscure principle of life, and the capacity of developement; and thus man himself, with all his intellectual and moral, as well as physical privileges, has been derived from

some creature of the ape or baboon tribe, urged by a constant tendency to improve, or at least to alter his condition.

As we have said, in order to arrive, even hypothetically, at this result, it is necessary to assume, besides a mere capacity for change, other positive and active principles, some of which we may notice. Thus, we must have, as the direct productions of nature on this hypothesis, certain monads or rough draughts, the primary *rudiments* of plants and animals. We must have, in these, a constant *tendency to progressive improvement*, to the attainment of higher powers and faculties than they possess; which tendency is again perpetually modified and controlled by the *force of external circumstances*. And in order to account for the simultaneous existence of animals in every stage of this imaginary progress, we must suppose that nature is compelled to be *constantly* producing those elementary beings, from which all animals are successively developed.

I need not stay to point out how extremely arbitrary every part of this scheme is; and how complex its machinery would be, even if it did account for the facts. It may be sufficient to observe, as others have done*, that the capacity of change, and of being influenced by external circumstances, such

* Lyell, Book III. Chap. i. p. 413.

as we really find it in nature, and therefore such as in science we must represent it, is a tendency, not to improve, but to deteriorate. When species are modified by external causes, they usually degenerate, and do not advance. And there is no instance of a species acquiring an entirely new sense, faculty, or organ, in addition to, or in the place of, what it had before.

Not only, then, is the doctrine of the transmutation of species in itself disproved by the best physiological reasonings, but the additional assumptions which are requisite, to enable its advocates to apply it to the explanation of the geological and other phenomena of the earth, are altogether gratuitous and fantastical.

Such is the judgment to which we are led by the examination of the discussions which have taken place on this subject. Yet in certain speculations, occasioned by the discovery of the *Sivatherium*, a new fossil animal from the Sub-Himalaya mountains of India, M. Geoffroy Saint-Hilaire speaks of the belief in the immutability of species as a conviction which is fading away from men's minds. He speaks too of the termination of the age of Cuvier, "la clôture du siècle de Cuvier," and of the commencement of a better zoological philosophy*. But though

* *Compte Rendu de l'Acad. des Sc.* 1837, No. 3. p. 81.

he expresses himself with great animation, I do not perceive that he adduces, in support of his peculiar opinions, any arguments in addition to those which he urged during the lifetime of Cuvier. And the reader* may recollect that the consideration of that controversy led us to very different anticipations from his, respecting the probable future progress of physiology. The discovery of the Sivatherium supplies no particle of proof to the hypothesis, that the existing species of animals are descended from extinct creatures which are specifically distinct: and we cannot act more wisely than in listening to the advice of that eminent naturalist, M. de Blainville†. "Against this hypothesis, which, up to the present time, I regard as purely gratuitous, and likely to turn geologists out of the sound and excellent road in which they now are, I willingly raise my voice, with the most absolute conviction of being in the right."

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* See p. 36. † *Compte Rendu*, 1837, No. 5, p. 168.

GEOLOGY.

THE QUESTION OF CREATION AS RELATED TO SCIENCE.

*The study of geology opens to us the spectacle of many groups of species which have, in the course of the earth's history, succeeded each other at vast intervals of time; one set of animals and plants disappearing, as it would seem, from the face of our planet, and others, which did not before exist, becoming the only occupants of the globe. And the dilemma then presents itself to us anew:—either we must accept the doctrine of the transmutation of species, and must suppose that the organized species of one geological epoch were transmuted into those of another by some long-continued agency of natural causes; or else, we must believe in many successive acts of creation and extinction of species, out of the common course of nature; acts which, therefore, we may properly call miraculous.

But since we reject the production of new species by means of external influence, do we then, it may be asked, accept the other side of the dilemma which we have stated; and admit a series of crea-

* *Hist. Ind. Sc.* Book XVIII. Chap. vi. Sect. 5.

tions of species, by some power beyond that which we trace in the ordinary course of nature?

To this question, the history and analogy of science, I conceive, teach us to reply as follows:—All palætiological sciences, all speculations which attempt to ascend from the present to the remote past, by the chain of causation, do also, by an inevitable consequence, urge us to look for the beginning of the state of things which we thus contemplate; but in none of these cases have men been able, by the aid of science, to arrive at a beginning which is homogeneous with the known course of events. The first origin of language, of civilization, of law and government, cannot be clearly made out by reasoning and research; and just as little, we may expect, will a knowledge of the origin of the existing and extinct species of plants and animals, be the result of physiological and geological investigation.

But, though philosophers have never yet demonstrated, and perhaps never will be able to demonstrate, what was that primitive state of things in the social and material worlds, from which the progressive state took its first departure; they can still, in all the lines of research to which we have referred, go very far back;—determine many of the remote circumstances of the past sequence of events;—ascend to a point which, from our position at least, seems to be near the origin;—and exclude many supposi-

tions respecting the origin itself. Whether, by the light of reason alone, men will ever be able to do more than this, it is difficult to say. It is, I think, no irrational opinion, even on grounds of philosophical analogy alone, that in all those sciences which look back and seek a beginning of things, we may be unable to arrive at a consistent and definite belief, without having recourse to other grounds of truth, as well as to historical research and scientific reasoning. When our thoughts would apprehend steadily the creation of things, we find that we are obliged to summon up other ideas than those which regulate the pursuit of scientific truths;—to call in other powers than those to which we refer natural events: it cannot, then, be considered as very surprising, if, in this part of our inquiry, we are compelled to look for other than the ordinary evidence of science.

Geology, forming one of the palætiological class of sciences, which trace back the history of the earth and its inhabitants on philosophical grounds, is thus associated with a number of other kinds of research, which are concerned about language, law, art, and consequently about the internal faculties of man, his thoughts, his social habits, his conception of right, his love of beauty. Geology being thus brought into the atmosphere of moral and mental speculations, it may be expected that her investigations of

the probable past will share an influence common to them; and that she will not be allowed to point to an origin of her own, a merely physical beginning of things; but that, as she approaches towards such a goal, she will be led to see that it is the origin of many trains of events, the point of convergence of many lines. It may be, that instead of being allowed to travel up to this focus of being, we are only able to estimate its place and nature, and to form of it such a judgment as this;—that it is not only the source of mere vegetable and animal life, but also of rational and social life, language and arts, law and order; in short, of all the progressive tendencies by which the highest principles of the intellectual and moral world have been and are developed, as well as of the succession of organic forms, which we find scattered, dead or living, over the earth.

This reflection concerning the natural scientific view of creation, it will be observed, has not been sought for, from a wish to arrive at such conclusions; but it has flowed spontaneously from the manner in which we have had to introduce geology into our classification of the sciences: and this classification was framed from an unbiassed consideration of the general analogies and guiding ideas of the various portions of our knowledge. Such remarks as we have made may on this account be considered more worthy of attention.

But such a train of thought must be pursued with caution. Although it may not be possible to arrive at a right conviction respecting the origin of the world, without having recourse to other than physical considerations, and to other than geological evidence; yet extraneous considerations, and extraneous evidence, respecting the nature of the beginning of things, must never be allowed to influence our physics or our geology. Our geological dynamics, like our astronomical dynamics, may be inadequate to carry us back to an origin of that state of things, of which it explains the progress: but this deficiency must be supplied, not by adding supernatural to natural geological dynamics, but by accepting, in their proper place, the views supplied by a portion of knowledge of a different character and order. If we include in theology the speculations to which we have recourse for this purpose, we must exclude them from geology. The two sciences may conspire, not by having any part in common; but because, though widely diverse in their lines, both point to a mysterious and invisible origin of the world.

All that which claims our assent on those higher grounds of which theology takes cognizance, must claim such assent as is consistent with those grounds; that is, it must require belief in respect of all that bears upon the highest relations of our being, those

on which depend our duties and our hopes. Doctrines of this kind may and must be conveyed and maintained, by means of information concerning the past history of man, and his social and material, as well as moral and spiritual fortunes. He who believes that a Providence has ruled the affairs of mankind, will also believe that a Providence has governed the material world. But any language in which the narrative of this government of the material world can be conveyed, must necessarily be very imperfect and inappropriate; being expressed in terms of those ideas which have been selected by men, in order to describe the appearances and relations of created things as they affect one another. In all cases, therefore, where we have to attempt to interpret such a narrative, we must feel that we are extremely liable to err; and most of all, when our interpretation refers to those material objects and operations which are most foreign to the main purpose of a history of providence. If we have to consider a communication containing a view of such a government of the world, imparted to us, as we may suppose, in order to point out the right direction for our feelings of trust, and reverence, and hope, towards the Governor of the world, we may expect that we shall be in no danger of collecting from our authority erroneous notions with regard to the power, and wisdom, and goodness of His

government; or with respect to our own place, duties, and prospects, and the history of our race, so far as our duties and prospects are concerned. But that we should rightly understand the detail of all events in the history of man, or of the skies, or of the earth, which are narrated for the purpose of thus giving a right direction to our minds, is by no means equally certain; and I do not think it would be too much to say, that an immunity from perplexity and error, in such matters, is, on general grounds, very improbable. It cannot then surprise us to find, that parts of such narrations which seem to refer to occurrences like those of which astronomers and geologists have attempted to determine the laws, have given rise to many interpretations, all inconsistent with one another, and most of them at variance with the best established principles of astronomy and geology.

It may be urged, that all truths must be consistent with all other truths, and that therefore the results of true geology or astronomy cannot be irreconcileable with the statements of true theology. And this universal consistency of truth with itself must be assented to; but it by no means follows that we must be able to obtain a full insight into the nature and manner of such a consistency. Such an insight would only be possible if we could obtain a clear view of that central body of truth, the source

of the principles which appear in the separate lines of speculation. To expect that we should see clearly how the providential government of the world is consistent with the unvarying laws by which its motions and developements are regulated, is to expect to understand thoroughly the laws of motion, of developement, and of providence; it is to expect that we may ascend from geology and astronomy to the creative and legislative center, from which proceeded earth and stars; and then descend again into the moral and spiritual world, because its source and center are the same as those of the material creation. It is to say that reason, whether finite or infinite, must be consistent with itself; and that, therefore, the finite must be able to comprehend the infinite, to travel from any one province of the moral and material universe to any other, to trace their bearing, and to connect their boundaries.

One of the advantages of the study of the history and nature of science in which we are now engaged is, that it warns us of the hopeless and presumptuous character of such attempts to understand the government of the world by the aid of science, without throwing any discredit upon the reality of our knowledge;—that while it shows how solid and certain each science is, so long as it refers its own facts to its own ideas, it confines each science within its own

limits, and condemns it as empty and helpless, when it pronounces upon those subjects which are extraneous to it. The error of persons who should seek a geological narrative in theological records, would be rather in the search itself than in their interpretation of what they might find; and in like manner the error of those who would conclude against a supernatural beginning, or a providential direction of the world, upon geological or physiological reasonings, would be, that they had expected those sciences alone to place the origin or the government of the world in its proper light.

Though these observations apply generally to all the palætiological sciences, they may be permitted here, because they have an especial bearing upon some of the difficulties which have embarrassed the progress of geological speculation; and though such difficulties are, I trust, nearly gone by, it is important for us to see them in their true bearing.

From what has been said, it follows that geology and astronomy are, of themselves, incapable of giving us any distinct and satisfactory account of the origin of the universe, or of its parts. We need not wonder, then, at any particular instance of this incapacity; as for example, that of which we have been speaking, the impossibility of accounting by any natural means for the production of all the successive tribes of plants and animals which have

peopled the world in the various stages of its progress, as geology teaches us. That they were, like our own animal and vegetable contemporaries, profoundly adapted to the condition in which they were placed, we have ample reason to believe; but when we inquire whence they came into this our world, geology is silent. The mystery of creation is not within the range of her legitimate territory; she says nothing, but she points upwards.

THE PHILOSOPHY OF BIOLOGY.

THE IDEA OF FINAL CAUSES.

*1. By an examination of those notions which enter into all our reasonings and judgments on living things, it appears that we conceive animal life as a vortex or cycle of moving matter in which the form of the vortex determines the motions, and these motions again support the form of the vortex: the stationary parts circulate the fluids, and the fluids nourish the permanent parts. Each portion ministers to the others, each depends upon the other. The parts make up the whole, but the existence of the whole is essential to the preservation of the parts. But parts existing under such conditions are *organs*, and the whole is *organized*. This is the fundamental conception of organization. "Organized beings," says the physiologist †, "are composed of a number of essential and mutually dependent parts." "An organized product of nature," says the great metaphysician‡, "is that in which all the parts are mutually ends and means."

2. It will be observed that we do not content ourselves with saying that in such a whole, all the

* Müller, *Elem.*, p. 18. † Kant, *Urtheilskraft*, p. 296.
‡ *Phil. Ind. Sc.* Book IX. Chap. vi.

parts are *mutually dependent*. This might be true even of a mechanical structure; it would be easy to imagine a framework in which each part should be necessary to the support of each of the others; for example, an arch of several stones. But in such a structure the parts have no properties which they derive from the whole. They are beams or stones when separate; they are no more when joined. But the same is not the case in an organized whole. The limb of an animal separated from the body, loses the properties of a limb and soon ceases to retain even its form.

3. Nor do we content ourselves with saying that the parts are *mutually causes and effects*. This is the case in machinery. In a clock, the pendulum by means of the escapement causes the descent of the weight, the weight by the same escapement keeps up the motion of the pendulum. But things of this kind may happen by accident. Stones slide from a rock down the side of a hill and cause it to be smooth; the smoothness of the slope causes stones still to slide. Yet no one would call such a slide an organized system. The system is organized, when the effects which take place among the parts are *essential to our conception of the whole;* when the whole would not *be* a whole, nor the parts, parts, except these effects were produced; when the effects not only happen in fact, but are included in the

idea of the object; when they are not only seen, but foreseen; not only expected, but intended: in short when, instead of being causes and effects, they are *ends* and *means*, as they are termed in the above definition.

Thus we necessarily include, in our Idea of Organization, the notion of an end, a purpose, a design; or, to use another phrase which has been peculiarly appropriated in this case, a *Final Cause*. This idea of a Final Cause is an essential condition in order to the pursuing our researches respecting organized bodies.

4. This Idea of Final Cause is not deduced from the phenomena by reasoning, but is assumed as the only condition under which we can reason on such subjects at all. We do not deduce the Idea of Space, or Time, or efficient Cause, from the phenomena about us, but necessarily look at phenomena as subordinate to these Ideas from the beginning of our reasoning. It is true, our ideas of relations of Space, and Time, and Force, may become much more clear by our familiarizing ourselves with particular phenomena: but still, the Fundamental Ideas are not generated, but unfolded; not extracted from the external world, but evolved from the world within. In like manner, in the contemplation of organic structures, we consider each part as subservient to some use, and we cannot study the

structure as organic without such a conception. This notion of adaptation,—this Idea of an End,—may become much more clear and impressive by seeing it exemplified in particular cases. But still, though suggested and evoked by special cases, it is not furnished by them. If it be not supplied by the mind itself, it can never be logically deduced from the phenomena. It is not a portion of the facts which we study, but it is a principle which connects, includes, and renders them intelligible; as our other Fundamental Ideas do the classes of facts to which they respectively apply.

5. This has already been confirmed by reference to fact; in the History of Physiology, I have shown that those who studied the structure of animals were irresistibly led to the conviction that the parts of this structure have each its end or purpose;—that each member and organ not merely produces a certain effect or answers a certain use, but is so framed as to impress us with the persuasion that it was constructed *for* that use:—that it was *intended* to produce the effect. It was there seen that this persuasion was repeatedly expressed in the most emphatic manner by Galen;—that it directed the researches and led to the discoveries of Harvey;—that it has always been dwelt upon as a favourite contemplation, and followed as a certain guide, by the best anatomists;—and that it is inculcated by

the physiologists of the profoundest views and most extensive knowledge of our own time. All these persons have deemed it a most certain and important principle of physiology, that in every organized structure, plant or animal, each intelligible part has its allotted office:—each organ is designed for its appropriate function:—that nature, in these cases, produces nothing in vain: that, in short, each portion of the whole arrangement has its *final cause;* an end to which it is adapted, and in this end, the reason that it is where and what it is.

6. This notion of Design in organized bodies must, I say, be supplied by the student of organization out of his own mind: a truth which will become clearer if we attend to the most conspicuous and acknowledged instances of *design.* The structure of the eye, in which the parts are curiously adjusted so as to produce a distinct image on the retina, as in an optical instrument;—the trochlear muscle of the eye, in which the tendon passes round a support and turns back, like a rope round a pulley;—the prospective contrivances for the preservation of animals, provided long before they are wanted, as the milk of the mother, the teeth of the child, the eyes and lungs of the fœtus:—these arrangements, and innumerable others, call up in us a persuasion that Design has entered into the plan of animal form and progress. And if we

bring in our minds this conception of Design, nothing can more fully square with and fit it, than such instances as these. But if we did not already possess the Idea of Design;—if we had not had our notion of mechanical contrivance awakened by inspection of optical instruments, or pulleys, or in some other way;—if we had never been conscious ourselves of providing for the future;—if this were the case, we could not recognise contrivance and prospectiveness in such instances as we have referred to. The facts are, indeed, admirably in accordance with these conceptions, when the two are brought together: but the facts and the conceptions come together from different quarters—from without and from within.

7. We may further illustrate this point by referring to the relations of travellers who tell us that when consummate examples of human mechanical contrivance have been set before savages, they have appeared incapable of apprehending them as proofs of design. This shews that in such cases the Idea of Design had not been developed in the minds of the people who were thus unintelligent: but it no more proves that such an idea does not naturally and necessarily arise, in the progress of men's minds, than the confused manner in which the same savages apprehend the relations of space, or number, or cause, proves that these ideas do not naturally be-

long to their intellects. All men have these ideas; and it is because they cannot help referring their sensations to such ideas, that they apprehend the world as existing in time and space, and as a series of causes and effects. It would be very erroneous to say that the belief of such truths is obtained by logical reasoning from facts. And in like manner we cannot logically deduce design from the contemplation of organic structures; although it is impossible for us, when the facts are clearly before us, not to find a reference to design operating in our minds.

8. Again; the evidence of the doctrine of Final Causes as a fundamental principle of Biology may be obscured and weakened in some minds by the constant habit of viewing this doctrine with suspicion as unphilosophical and at variance with morphology. By cherishing such views it is probable that many persons, physiologists and others, have gradually brought themselves to suppose that many or most of the arrangements which are familiarly adduced as instances of design may be accounted for, or explained away;—that there is a certain degree of prejudice and narrowness of comprehension in that lively admiration of the adaptation of means to ends which common minds derive from the spectacle of organic arrangements. And yet, even in persons accustomed to these views, the strong and natural

influence of the Idea of a Final Cause, the spontaneous recognition of the relation of means to an end as the assumption which makes organic arrangements intelligible, breaks forth when we bring before them a new case, with regard to which their genuine convictions have not yet been modified by their intellectual habits. I will offer, as an example which may serve to illustrate this, the discoveries recently made with regard to the process of suckling of the kangaroo. In the case of this, as of other pouched animals, the young animal is removed, while very small and imperfectly formed, from the womb to the pouch, in which the teats are, and is there placed with its lips against one of the nipples. But the young animal taken altogether is not so large as the nipple, and is therefore incapable of sucking after the manner of common mammals. Here is a difficulty: how is it overcome?—By an appropriate *contrivance:* the nipple, which in common mammals is not furnished with any muscle, is in the kangaroo provided with a powerful extrusory muscle by which the mother can inject the milk into the mouth of her offspring. And again; in order to give attachment to this muscle there is a bone which is not found in animals of other kinds. But this mode of solving the problem of suckling so small a creature introduces another difficulty. If the milk is injected into the mouth of the young

one, without any action of its own muscles, what is to prevent the fluid entering the windpipe and producing suffocation? How is this danger avoided? —By another appropriate *contrivance:* there is a funnel in the back of the throat by which the air-passage is completely separated from the passage for nutriment, and the injected milk passes in a divided stream on each side of the larynx to the œsophagus*. And as if to show that this apparatus is really formed with a view to the wants of the young one, the structure alters in the course of the animal's growth; and the funnel, no longer needed, is modified and disappears.

With regard to this and similar examples, the remark which I would urge is this:—that no one, however prejudiced or unphilosophical he may in general deem the reference to Final Causes, can, at the first impression, help regarding this curious system of arrangement as the means to an end. So contemplated, it becomes significant, intelligible, admirable: without such a principle, it is an unmeaning complexity, a collection of contradictions, producing an almost impossible result by a portentous conflict of chances. The parts of this apparatus cannot have produced one another; one part is in the mother; another part in the young

* Mr. Owen, in *Phil. Trans.*, 1834, p. 348.

one: without their harmony they could not be effective; but nothing except design can operate to make them harmonious. They are *intended* to work together; and we cannot resist the conviction of this intention when the facts first come before us. Perhaps there may hereafter be physiologists who, tracing the gradual developement of the parts of which we have spoken, and the analogies which connect them with the structures of other animals, may think that this developement, these analogies, account for the conformation we have described; and may hence think lightly of the explanation derived from the reference to Final Causes. Yet surely it is clear, on a calm consideration of the subject, that the latter explanation is not disturbed by the former; and that the observer's first impression, that this is "an irrefragable evidence of creative foresight*," can never be obliterated; however much it may be obscured in the minds of those who confuse this view by mixing it with others which are utterly heterogeneous to it, and therefore cannot be contradictory.

9. I have elsewhere† remarked how physiologists, who thus look with suspicion and dislike upon the introduction of Final Causes into physiology, have still been unable to exclude from their speculations

* Mr. Owen, in *Phil. Trans.*, 1834, p. 349.

† *Bridgewater Treatise*, p. 352.

causes of this kind. Thus Cabanis says*, "I regard with the great Bacon, the philosophy of Final Causes as sterile; but I have elsewhere acknowledged that it was very difficult for the most cautious man never to have recourse to them in his explanations." Accordingly, he says, "The partisans of Final Causes nowhere find arguments so strong in favour of their way of looking at nature as in the laws which preside and the circumstances of all kinds which concur in the reproduction of living races. In no case do the means employed appear so clearly relative to the end." And it would be easy to find similar acknowledgments, express or virtual, in other writers of the same kind. Thus Bichat, after noting the difference between the organic sensibility by which the organs are made to perform their offices, and the animal sensibility of which the nervous center is the seat, says†, "No doubt it will be asked, *why*,"—that is, as we shall see, for what *end*—"the organs of internal life have received from nature an inferior degree of sensibility only, and why they do not transmit to the brain the impressions which they receive, while all the acts of the animal life imply this transmission? The reason is simply this, that all the phenomena which establish our connexions with surrounding objects *ought to be*,

* *Rapports de Physique et du Moral*, I. 299.
† *Life and Death*, (trans.) p. 32.

and are in fact, under the influence of the will; while all those which serve for the purpose of assimilation only, escape, and *ought* indeed to escape, such influence." The *reason* here assigned is the Final Cause; which, as Bichat justly says, we cannot help asking for.

10. Again; I may quote from the writer last mentioned another remark, which shews that in the organical sciences, and in them alone, the Idea of forces as Means acting to an End, is inevitably assumed and acknowledged as of supreme authority. In Biology alone, observes Bichat*, have we to contemplate the state of *disease*. "Physiology is to the movements of living bodies, what astronomy, dynamics, hydraulics, &c., are to those of inert matter: but these latter sciences have no branches which correspond to them as pathology corresponds to physiology. For the same reason all notion of a medicament is repugnant to the physical sciences. A medicament has for its object to bring the properties of the system back to their natural type; but the physical properties never depart from this type, and have no need to be brought back to it: and thus there is nothing in the physical sciences which holds the place of therapeutick in physiology."

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* *Anatomie Generale*, I. liij.

Or, as we might express it otherwise, of inert forces we have no conception of what they *ought to do*, except what they *do*. The forces of gravity, elasticity, affinity, never act in a *diseased* manner; we never conceive them as failing in their purpose; for we do not conceive them as having any purpose which is answered by one mode of their action rather than another. But with organical forces the case is different; they are necessarily conceived as acting for the preservation and developement of the system in which they reside. If they do not do this, they fail, they are deranged, diseased. They have for their object to conform the living being to a certain type; and if they cause or allow it to deviate from this type, their action is distorted, morbid, contrary to the ends of nature. And thus this conception of organized beings as susceptible of disease, implies the recognition of a state of health, and of the organs and the vital forces as means for preserving this normal condition. The state of health and of perpetual developement is necessarily contemplated as the Final Cause of the processes and powers with which the different parts of plants and animals are endowed.

11. This idea of a Final Cause is applicable as a fundamental and regulative idea to our speculations concerning organized creatures only. That there is

a purpose in many other parts of the creation, we find abundant reason to believe from the arrangements and laws which prevail around us. But this persuasion is not to be allowed to regulate and direct our reasonings with regard to inorganic matter, of which conception the relation of means and end forms no essential part. In mere Physics, Final Causes, as Bacon has observed, are not to be admitted as a principle of reasoning. But in the organical sciences, the assumption of design and purpose in every part of every whole, that is, the pervading idea of Final Cause, is the basis of sound reasoning and the source of true doctrine.

12. The Idea of Final Cause, of end, purpose, design, intention, is altogether different from the Idea of Cause, as efficient cause, which we formerly had to consider; and on this account the use of the word *Cause* in this phrase has been objected to. If the idea be clearly entertained and steadily applied, the word is a question of subordinate importance. The term Final Cause has been long familiarly used, and appears not likely to lead to confusion.

13. The consideration of Final Causes, both in physiology and in other subjects, has at all times attracted much attention, in consequence of its bearing upon the belief of an Intelligent Author of the Universe. I do not intend, in this place, to

pursue the subject far in this view: but there is one antithesis of opinion, already noticed in speaking of Physiology, on which I will again make a few remarks*.

It has appeared to some persons that the mere aspect of order and symmetry in the works of nature —the contemplation of comprehensive and consistent law—is sufficient to lead us to the conception of a design and intelligence producing the order and carrying into effect the law. Without here attempting to decide whether this is true, we may discern, after what has been said, that the conception of design, arrived at in this manner, is altogether different from that idea of design which is suggested to us by organized bodies, and which we describe as the doctrine of Final Causes. The regular form of a crystal, whatever beautiful symmetry it may exhibit, whatever general laws it may exemplify, does not prove design in the same manner in which design is proved by the provisions for the preservation and growth of the seeds of plants, and of the young of animals. The law of universal gravitation, however wide and simple, does not impress us with the belief of a purpose, as does that propensity by which the two sexes of each animal are brought together. If it could be shewn that

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* See p. 23.

the symmetrical structure of a flower results from laws of the same kind as those which determine the regular forms of crystals, or the motions of the planets, the discovery might be very striking and important, but it would not at all come under our idea of Final Cause.

14. Accordingly, there have been, in modern times, two different schools of physiologists, the one proceeding upon the idea of Final Causes, the other school seeking in the realm of organized bodies wide laws and analogies from which that idea is excluded. All the great biologists of preceding times, and some of the greatest of modern times, have belonged to the former school; and especially Cuvier, who may be considered as the head of it. It was solely by the assiduous application of this principle of Final Cause, as he himself constantly declared, that he was enabled to make the discoveries which have rendered his name so illustrious, and which contain a far larger portion of important anatomical and biological truth than it ever before fell to the lot of one man to contribute to the science.

15. The opinions which have been put in opposition to the principle of Final Causes have, for the most part, been stated vaguely and ambiguously. Among the most definite of such principles, is that which, in the History of the subject, I have termed the Principle of metamorphosed and developed Sym-

metry, upon which has been founded the science of Morphology.

The reality and importance of this principle are not to be denied by us: we have shown how they are proved by its application in various sciences, and especially in botany. But those advocates of this principle who have placed it in antithesis to the doctrine of Final Causes, have by this means done far more injustice to their own favourite doctrine than damage to the one which they opposed. The adaptation of the bones of the skeleton to the muscles, the provision of fulcrums, projecting processes, channels, so that the motions and forces shall be such as the needs of life require, cannot possibly become less striking and convincing, from any discovery of general analogies of one animal frame with another, or of laws connecting the developement of different parts. Whenever such laws are discovered, we can only consider them as the means of producing that adaptation which we so much admire. Our conviction that the Artist works intelligently, is not destroyed, though it may be modified and transferred, when we obtain a sight of his tools. Our discovery of laws cannot contradict our persuasion of ends; our Morphology cannot prejudice our Teleology.

16. The irresistible and constant apprehension of a purpose in the forms and functions of animals

has introduced into the writings of speculators on these subjects various forms of expression, more or less precise, more or less figurative; as, that animals are framed with a view to the part which they have to play;—that nature does nothing in vain; that she employs the best means for her ends; and the like. However metaphorical or inexact any of these phrases may be in particular, yet taken altogether, they convey, clearly and definitely enough to preclude any serious error, a principle of the most profound reality and of the highest importance in the organical sciences. But some adherents of the morphological school of which I have spoken reject, and even ridicule, all such modes of expression. "I know nothing," says M. Geoffroy Saint-Hilaire, "of animals which have to play a part in nature. I cannot make of nature an intelligent being who does nothing in vain; who acts by the shortest mode; who does all for the best." The philosophers of this school, therefore, do not, it would seem, feel any of the admiration which is irresistibly excited in all the rest of mankind at the contemplation of the various and wonderful adaptations for the preservation, the enjoyment, the continuation of the creatures which people the globe;—at the survey of the mechanical contrivances, the chemical agencies, the prospective arrangements, the compensations, the minute adap-

tations, the comprehensive interdependencies, which zoology and physiology have brought into view, more and more, the further their researches have been carried. Yet the clear and deep-seated conviction of the reality of these provisions, which the study of anatomy produces in its most profound and accurate cultivators, cannot be shaken by any objections to the metaphors or terms in which this conviction is clothed. In regard to the Idea of a Purpose in organization, as in regard to any other idea, we cannot fully express our meaning by phrases borrowed from any extraneous source; but that impossibility arises precisely from the circumstance of its being a Fundamental Idea which is inevitably assumed in our representation of each special fact. The same objection has been made to the idea of mechanical *force*, on account of its being often expressed in metaphorical language; for writers have spoken of an *energy*, *effort*, or *solicitation* to motion; and bodies have been said to be *animated* by a force. Such language, it has been urged, implies volition, and the act of animated beings. But the idea of force as distinct from mere motion,—as the cause of motion, or of tendency to motion,—is not on that account less real. We endeavour in vain to conduct our mechanical reasonings without the aid of this idea, and must express it as we can. Just as little can we reason concerning organized beings

without assuming that each part has its function, each function its purpose; and so far as our phrases imply this, they will not mislead us, however inexact, or however figurative they be.

17. The doctrine of a purpose in organization has been sometimes called the doctrine of *the Conditions of Existence;* and has been stated as teaching that each animal must be so framed as to contain in its structure the conditions which its existence requires. When expressed in this manner, it has given rise to the objection, that it merely offers an identical proposition; since no animal *can* exist without such conditions. But in reality, such expressions as those just quoted give an inadequate statement of the Principle of a Final Cause. For we discover in innumerable cases, arrangements in an animal, of which we see, indeed, that they are subservient to its well being; but the nature of which we never should have been able at all to conjecture, from considering what was necessary to its existence, and which strike us, no less by their unexpectedness than by their adaptation: so far are they from being presented by any perceptible necessity. Who would venture to say that the trochlear muscle, or the power of articulate speech, must occur in man, because they are the necessary conditions of his existence? When, indeed, the general scheme and mode of being of

an animal are known, the expert and profound anatomist can reason concerning the proportions and form of its various parts and organs, and prove in some measure what their relations must be. We can assert, with Cuvier, that certain forms of the viscera require certain forms of the teeth, certain forms of the limbs, certain powers of the senses. But in all this, the functions of self-nutrition and digestion are supposed already existing as ends: and it being taken for granted, as the only conceivable basis of reasoning, that the organs are means to these ends, we may discover what modifications of these organs are necessarily related to and connected with each other. Instead of terming this rule of speculation merely "the principle of the conditions of existence," we might term it "the principle of the conditions of organs as *means* adapted to animal existence as their *end*." And how far this principle is from being a mere barren truism, the extraordinary discoveries made by the great assertor of the principle, and universally assented to by naturalists, abundantly prove. The vast extinct creation which is recalled to life in Cuvier's great work, the *Ossemens Fossiles*, cannot be the consequence of a mere identical proposition.

18. It has been objected, also, that the doctrine of Final Causes supposes us to be acquainted with the intentions of the Creator; which, it is insinuated,

is a most presumptuous and irrational basis for our reasonings. But there can be nothing presumptuous or irrational in reasoning on that basis, which if we reject, we cannot reason at all. If men really can discern, and cannot help discerning, a design in certain portions of the works of creation, this perception is the soundest and most satisfactory ground for the convictions to which it leads. The Ideas which we necessarily employ in the contemplation of the world around us, afford us the only natural means of forming any conception of the Creator and Governor of the Universe; and if we are by such means enabled to elevate our thoughts, however inadequately, towards Him, where is the presumption of doing so? or rather, where is the wisdom of refusing to open our minds to contemplations so animating and elevating, and yet so entirely convincing? We possess the ideas of time and space, under which all the objects of the universe present themselves to us; and in virtue of these ideas thus possessed, we believe the Creator to be eternal and omnipotent. When we find that we, in like manner, possess the idea of a Design in Creation, and that with regard to ourselves, and creatures more or less resembling ourselves, we cannot but contemplate their constitution under this idea, we cannot abstain from ascribing to the Creator the infinite

profundity and extent of design to which all these special instances belong as parts of a whole.

19. I have here considered Design as manifest in organization only: for in that field of speculation it is forced upon us as contained in all the phenomena, and as the only mode of our understanding them. The existence of Final Causes has often been pointed out in other portions of the creation;— in the apparent adaptations of the various parts of the earth and of the solar system to each other and to organized beings. In these provinces of speculation, however, the principle of Final Causes is no longer the basis and guide, but the sequel and result of our physical reasonings. If in looking at the universe, we follow the widest analogies of which we obtain a view, we see, however dimly, reason to believe that all its laws are adapted to each other, and intended to work together for the benefit of its organic population, and for the general welfare of its rational tenants. On this subject, however, not immediately included in the principle of Final Causes as here stated, I shall not dwell. I will only make this remark; that the assertion appears to be quite unfounded, that as science advances from point to point, Final Causes recede before it, and disappear one after the other. The principle of design changes its mode of application indeed, but

it loses none of its force. We no longer consider particular facts as produced by special interpositions, but we consider design as exhibited in the establishment and adjustment of the laws by which particular facts are produced. We do not look upon each particular cloud as brought near us that it may drop fatness on our fields, but the general adaptation of the laws of heat, and air, and moisture, to the promotion of vegetation, does not become doubtful. We do not consider the sun as less intended to warm and vivify the tribes of plants and animals, because we find that, instead of revolving round the earth as an attendant, the earth along with other planets revolves round him. We are rather, by the discovery of the general laws of nature, led into a scene of wider design, of deeper contrivance, of more comprehensive adjustments. Final causes, if they appear driven further from us by such an extension of our views, embrace us only with a vaster and more majestic circuit: instead of a few threads connecting some detached objects, they become a stupendous net-work, which is wound round and round the universal frame of things.

PALÆTIOLOGY.

NATURE OF PALÆTIOLOGY.

*1. The class of Sciences which I designate as *Palætiological* are those in which the object is to ascend from the present state of things to a more ancient condition, from which the present is derived by intelligible causes. As conspicuous examples of this class we may take Geology, Glossology or Comparative Philology, and Comparative Archæology. These provinces of knowledge might perhaps be intelligibly described as Histories; the History of the Earth,—the History of Languages,—the History of Arts. But these phrases would not fully describe the sciences we have in view; for the object to which we now suppose their investigations to be directed is not merely to ascertain what the series of events has been, as in the common forms of History, but also how it has been brought about. These sciences are to treat of causes as well as of effects. Such researches might be termed *philosophical history;* or, in order to mark more distinctly that the *causes* of events are the leading object of attention, *ætiological his-*

* *Phil. Ind. Sc.* Book x. Chap. i.

tory. But since it will be more convenient to describe this class of sciences by a single appellation, I have taken the liberty of proposing to call them* *Palætiological* Sciences.

While *Palæontology* describes the beings which have lived in former ages without investigating their causes, and *Ætiology* treats of causes without distinguishing historical from mechanical causation; *Palætiology* is a combination of the two sciences; exploring by means of the second the phenomena presented by the first. The portions of knowledge which I include in this term are palæontological ætiological sciences.

2. All these sciences are connected by this bond;—that they all endeavour to ascend to a past state, by considering what is the present state of things, and what are the causes of change. Geology examines the existing appearances of the materials which form the earth, infers from them previous conditions, and speculates concerning the forces by which one condition has been made to succeed another. Another science, cultivated with great

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* A philological writer, in a very interesting work, (Mr. Donaldson, in his *New Cratylus*, p. 12,) expresses his dislike of this word, and suggests that I must mean *palæ-ætiological*. I think the word is more likely to obtain currency in the more compact and euphonious form in which I have used it. It has been adopted by Mr. Winning, in his *Manual of Comparative Philology*.

zeal and success in modern times, compares the languages of different countries and nations, and by an examination of their materials and structure, endeavours to determine their descent from one another: this science has been termed Comparative Philology or Ethnography; and by the French, *Linguistique*, a word which we might imitate in order to have a single name for the science, but the Greek derivative *Glossology* appears to be more convenient in its form. The progress of the Arts (Architecture and the like); how one stage of their culture produced another; and how far we can trace their maturest and most complete condition to their earliest form in various nations;— are problems of great interest belonging to another subject, which we may for the present term Comparative Archæology. I have already noticed, in the *History**, how the researches into the origin of natural objects, and those relating to works of art, pass by slight gradations into each other; how the examination of the changes which have affected an ancient temple or fortress, harbour or river, may concern alike the geologist and the antiquary. Cuvier's assertion that the geologist is an antiquary of a new order, is perfectly correct, for both are palætiologists.

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* *Hist. Ind. Sci.* III., 482.

3. We are very far from having exhausted, by this enumeration, the class of sciences which are thus connected. We may easily point out many other subjects of speculation of the same kind. As we may look back towards the first condition of our planet, we may in like manner turn our thoughts towards the first condition of the solar system, and try whether we can discern any traces of an order of things antecedent to that which is now established; and if we find, as some great mathematicians have conceived, indications of an earlier state in which the planets were not yet gathered into their present forms, we have, in the pursuit of this train of research, a palætiological portion of Astronomy. Again, as we may inquire how languages, and how man, have been diffused over the earth's surface from place to place, we may make the like inquiry with regard to the races of plants and animals, founding our inferences upon the existing geographical distribution of the animal and vegetable kingdoms: and thus the Geography of Plants and of Animals also becomes a portion of Palætiology. Again, as we can in some measure trace the progress of Arts from nation to nation and from age to age, we can also pursue a similar investigation with respect to the progress of Mythology, of Poetry, of Government, of Law. Thus the philosophical history of the human race, viewed

with reference to these subjects, if it can give rise to knowledge so exact as to be properly called Science, will supply sciences belonging to the class I am now to consider.

4. It is not an arbitrary and useless proceeding to construct such a class of sciences. For wide and various as their subjects are, it will be found that they have all certain principles, maxims, and rules of procedure in common; and thus may reflect light upon each other by being treated of together. Indeed it will, I trust, appear, that we may by such a juxtaposition of different speculations, obtain most salutary lessons. And questions, which, when viewed as they first present themselves under the aspect of a special science, disturb and alarm men's minds, may perhaps be contemplated more calmly, as well as more clearly, when they are considered as general problems of palætiology.

5. It will at once occur to the reader that, if we include in the circuit of our classification such subjects as have been mentioned,—politics and law, mythology and poetry,—we are travelling very far beyond the material sciences within whose limits we at the outset proposed to confine our discussion of principles. But we shall remain faithful to our original plan; and for that purpose shall confine ourselves in this work to those palætiological sciences which deal with material things. It is

true, that the general principles and maxims which regulate these sciences apply also to investigations of a parallel kind respecting the products which result from man's imaginative and social endowments. But although there may be a similarity in the general form of such portions of knowledge, their materials are so different from those with which we have been hitherto dealing, that we cannot hope to take them into our present account with any profit. Language, Government, Law, Poetry, Art, embrace a number of peculiar Fundamental Ideas, hitherto not touched upon in the disquisitions in which we have been engaged; and most of them involved in far greater perplexity and ambiguity, the subject of controversies far more vehement, than the Ideas we have hitherto been examining. We must therefore avoid resting any part of our philosophy upon sciences, or supposed sciences, which treat of such subjects. To attend to this caution, is the only way in which we can secure the advantage we proposed to ourselves at the outset, of taking, as the basis of our speculations, none but systems of undisputed truths, clearly understood and expressed*. We have already said that we must, knowingly and voluntarily, resign that livelier and warmer interest which doctrines

* See *Phil. Ind. Sci.* Vol. 1. p. 8.

on subjects of Polity or Art possess, and content ourselves with the cold truths of the material sciences, in order that we may avoid having the very foundations of our philosophy involved in controversy, doubt, and obscurity.

6. We may remark, however, that the necessity of rejecting from our survey a large portion of the researches which the general notion of Palætiology includes, suggests one consideration which adds to the interest of our task. We began our inquiry with the trust that any sound views which we should be able to obtain respecting the nature of truth in the physical sciences, and the mode of discovering it, must also tend to throw light upon the nature and prospects of knowledge of all other kinds;—must be useful to us in moral, political, and philological researches. We stated this as a confident anticipation; and the evidence of the justice of our belief already begins to appear. We have seen that biology leads us to psychology, if we choose to follow the path; and thus the passage from the material to the immaterial has already unfolded itself at one point; and we now perceive that there are several large provinces of speculation which concern subjects belonging to man's immaterial nature, and which are governed by the same laws as sciences altogether physical. It is not our business here to dwell on the pro-

spects which our philosophy thus opens to our contemplation; but we may allow ourselves, in this last stage of our pilgrimage among the foundations of the physical sciences, to be cheered and animated by the ray that thus beams upon us, however dimly, from a higher and brighter region.

But in our reasonings and examples we shall mainly confine ourselves to the physical sciences; and for the most part to Geology, which in the *History* I have put forwards as the best representative of the Palætiological Sciences.

DOCTRINE OF CATASTROPHES AND OF UNIFORMITY.

1. *Doctrine of Catastrophes.*—The attempts to frame a theory of the earth have brought into view two completely opposite opinions:—one, which represents the course of nature as *uniform* through all ages, the causes which produce change having had the same intensity in former times which they have at the present day;—the other opinion, which sees in the present condition of things evidences of *catastrophes;* changes of a more sweeping kind, and produced by more powerful agencies than those which occur in recent times. Geologists who held the latter opinion, maintained that the forces which have elevated the Alps or the Andes to their present

height could not have been any forces which are now in action: they pointed to vast masses of strata hundreds of miles long, thousands of feet thick, thrown into highly-inclined positions, fractured, dislocated, crushed: they remarked that upon the shattered edges of such strata they found enormous accumulations of fragments and rubbish, rounded by the action of water, so as to denote ages of violent aqueous action: they conceived that they saw instances in which whole mountains of rock in a state of igneous fusion, must have burst the earth's crust from below: they found that in the course of the revolutions by which one stratum of rock was placed upon another, the whole collection of animal species which tenanted the earth and the seas had been removed, and a new set of living things introduced in its place: finally, they found above all the strata vast masses of sand and gravel containing bones of animals, and apparently the work of a mighty deluge. With all these proofs before their eyes they thought it impossible not to judge that the agents of change by which the world was urged from one condition to another till it reached its present state, must have been more violent, more powerful, than any which we see at work around us. They conceived that the evidence of "catastrophes" was irresistible.

2. *Doctrine of Uniformity.*—I need not here repeat the narrative (given in the History*) of the process by which this formidable array of proofs was, in the minds of some eminent geologists, weakened, and at last overcome. This was done by showing that the sudden breaks in the succession of strata were apparent only, the discontinuity of the series which occurred in one country being removed by terms interposed in another locality: by urging that the total effect produced by existing causes, taking into account the accumulated result of long periods, is far greater than a casual speculator would think possible: by making it appear that there are in many parts of the world evidences of a slow and imperceptible rising of the land since it was the habitation of now existing species: by proving that it is not universally true that the strata separated in time by supposed catastrophes contain distinct species of animals: by pointing out the limited fields of the supposed diluvial action: and finally, by remarking that though the *creation* of species is a mystery, the *extinction* of them is going on in our own day. Hypotheses were suggested, too, by which it was conceived that the change of climate might be explained, which, as the consideration of the fossil remains seemed to show, must have taken place

* *Hist. Ind. Sci.*, III. 612.

between the ancient and the modern times. In this manner the whole evidence of catastrophes was explained away: the notion of a series of paroxysms of violence in the causes of change was represented as a delusion arising from our contemplating short periods only in the action of present causes: length of time was called in to take the place of intensity of force: and it was declared that geology need not despair of accounting for the revolutions of the earth, as astronomy accounts for the revolutions of the heavens, by the universal action of causes which are close at hand to us, operating through time and space without variation or decay.

An antagonism of opinions, somewhat of the same kind as this, will be found to manifest itself in the other Palætiological Sciences as well as in Geology; and it will be instructive to endeavour to balance these opposite doctrines. I will mention some of the considerations which bear upon the subject.

3. *Is Uniformity probable à priori?*—The doctrine of Uniformity in the course of nature has sometimes been represented by its adherents as possessing a great degree of *à priori* probability. It is highly unphilosophical, it has been urged, to assume that the causes of the geological events of former times were of a different kind from causes now in action, if causes of this latter kind can in

any way be made to explain the facts. The analogy of all other sciences compels us, it was said, to explain phenomena by known, not by unknown, causes. And on these grounds the geological teacher recommended* "an earnest and patient endeavour to reconcile the indications of former change with the evidence of gradual mutations now in progress."

But on this we may remark, that if by *known* causes we mean causes acting with the same intensity which they have had during historical times, the restriction is altogether arbitrary and groundless. Let it be granted, for instance, that many parts of the earth's surface are now undergoing an imperceptible rise. It is not pretended that the rate of this elevation is rigorously uniform; what, then, are the limits of its velocity? Why may it not increase so as to assume that character of violence which we may term a *catastrophe* with reference to all changes hitherto recorded? Why may not the rate of elevation be such that we may conceive the strata to assume *suddenly* a position nearly vertical? and is it, in fact, easy to conceive a position of strata nearly vertical, a position which occurs so frequently, to be *gradually* assumed? In cases where the strata are nearly vertical, as in the Isle of Wight, and hundreds of other places, or where they are actually

* Lyell, B. iv. c. i. p. 328.

inverted, as sometimes occurs, are not the causes which have produced the effect as truly *known* causes, as those which have raised the coasts where we trace the former beach in an elevated terrace? If the latter case proves *slow* elevation, does not the former case prove *rapid* elevation? In neither case have we any measure of the time employed in the change; but does not the very nature of the results enable us to discern, that if one was gradual, the other was comparatively sudden?

The causes which are now elevating a portion of Scandinavia can be called known *causes*, only because we know the *effect*. Are not the causes which have elevated the Alps and the Andes known causes in the same sense? We know nothing in either case which confines the intensity of the force within any limit, or prescribes to it any law of uniformity. Why, then, should we make a merit of cramping our speculations by such assumptions? Whether the causes of change do act uniformly;—whether they oscillate only within narrow limits;—whether their intensity in former times was nearly the same as it now is;—these are precisely the questions which we wish Nature to answer to us impartially and truly: where is then the wisdom of "an earnest and patient endeavour" to secure an *affirmative* reply?

Thus I conceive that the assertion of an *à priori*

claim to probability and philosophical spirit in favour of the doctrine of uniformity, is quite untenable. We must learn from an examination of all the facts, and not from any assumption of our own, whether the course of nature be uniform. The limit of intensity being really unknown, catastrophes are just as probable as uniformity. If a volcano may repose for a thousand years, and then break out and destroy a city; why may not another volcano repose for ten thousand years, and then destroy a continent; or if a continent, why not the whole habitable surface of the earth?

4. *Cycle of Uniformity indefinite.*—But this argument may be put in another form. When it is said that the course of nature is uniform, the assertion is not intended to exclude certain smaller variations of violence and rest, such as we have just spoken of;—alternations of activity and repose in volcanos; or earthquakes, deluges, and storms, interposed in a more tranquil state of things. With regard to such occurrences, terrible as they appear at the time, they may not much affect the average rate of change; there may be a *cycle*, though an irregular one, of rapid and slow change; and if such cycles go on succeeding each other, we may still call the order of nature uniform, notwithstanding the periods of violence which it involves. The maximum and minimum intensities of the forces of mutation alternate with

one another; and we may estimate the average course of nature as that which corresponds to something between the two extremes.

But if we thus attempt to maintain the uniformity of nature by representing it as a series of *cycles*, we find that we cannot discover, in this conception, any solid ground for excluding catastrophes. What is the length of that cycle the repetition of which constitutes uniformity? What interval from the maximum to the minimum does it admit of? We may take for our cycle a hundred or a thousand years, but evidently such a proceeding is altogether arbitrary. We may mark our cycles by the greatest known paroxysms of volcanic and terremotive agency, but this procedure is no less indefinite and inconclusive than the other.

But further; since the cycle in which violence and repose alternate is thus indefinite in its length and in its range of activity, what ground have we for assuming more than *one* such cycle, extending from the origin of things to the present time? Why may we not suppose the maximum force of the causes of change to have taken place at the earliest period, and the tendency towards the minimum to have gone on ever since? Or instead of only one cycle, there may have been several, but of such length that our historical period forms a portion only of the last;—the feeblest portion of the latest cycle. And thus

violence and repose may alternate upon a scale of time and intensity so large, that man's experience supplies no evidence enabling him to estimate the amount. The course of things is *uniform*, to an Intelligence which can embrace the succession of several cycles, but it is *catastrophic* to the contemplation of man, whose survey can grasp a part only of one cycle. And thus the hypothesis of uniformity, since it cannot exclude degrees of change, nor limit the range of these degrees, nor define the interval of their recurrence, cannot possess any essential simplicity which, previous to inquiry, gives it a claim upon our assent superior to that of the opposite catastrophic hypothesis.

5. *Uniformitarian Arguments are Negative only.*—There is an opposite tendency in the mode of maintaining the catastrophist and the uniformitarian opinions, which depends upon their fundamental principles, and shows itself in all the controversies between them. The Catastrophist is affirmative, the Uniformitarian is negative in his assertions: the former is constantly attempting to construct a theory; the latter delights in demolishing all theories. The one is constantly bringing fresh evidence of some great past event, or series of events, of a striking and definite kind; his antagonist is at every step explaining away the evidence, and showing that it proves nothing. One geologist adduces his proofs

of a vast universal deluge; but another endeavours to show that the proofs do not establish either the universality or the vastness of such an event. The inclined broken edges of a certain formation covered with their own fragments beneath superjacent horizontal deposits are at one time supposed to prove a catastrophic breaking up of the earlier strata; but this opinion is controverted by showing that the same formations, when pursued into other countries, exhibit a uniform gradation from the lower to the upper, with no trace of violence. Extensive and lofty elevations of the coast, continents of igneous rock, at first appear to indicate operations far more gigantic than those which now occur; but attempts are soon made to show that time only is wanting to enable the present age to rival the past in the production of such changes. Each new fact adduced by the catastrophist is at first striking and apparently convincing; but as it becomes familiar, it strikes the imagination less powerfully; and the uniformitarian, constantly labouring to produce some imitation of it by the machinery which he has so well studied, at last in every case seems to himself to succeed, so far as to destroy the effect of his opponent's evidence.

This is so with regard to more remote, as well as with regard to immediate evidences of change. When it is ascertained that in every part of the

earth's crust the temperature increases as we descend below the surface, at first this fact seems to indicate a central heat: and a central heat naturally suggests an earlier state of the mass, in which it was incandescent, and from which it is now cooling. But this original incandescence of the globe of the earth is manifestly an entire violation of the present course of things; it belongs to the catastrophist view, and the advocates of uniformity have to explain it away. Accordingly, one of them holds that this increase of heat in descending below the surface may very possibly not go on all the way to the center. The heat which increases at first as we descend, may, he conceives, afterwards decrease; and he suggests causes which may have produced such a succession of hotter and colder shells within the mass of the earth. I have mentioned this suggestion in the History of Geology; and have given my reasons for believing it altogether untenable*. Other persons also, desirous of reconciling this subterraneous heat with the tenet of uniformity, have offered another suggestion:—that the warmth or incandescence of the interior parts of the earth does not arise out of an originally hot condition from which it is gradually cooling, but results from chemical action constantly going on among the materials of the earth's substance. And

* *Hist. Ind. Sci.*, III. 562, and note.

thus new attempts are perpetually making, to escape from the cogency of the reasonings which send us towards an original state of things different from the present. Those who theorize concerning an origin go on building up the fabric of their speculations, while those who think such theories unphilosophical, ever and anon dig away the foundation of this structure. As we have already said, the uniformitarian's doctrines are a collection of negatives.

This is so entirely the case, that the uniformitarian would for the most part shrink from maintaining as positive tenets the explanations which he so willingly uses as instruments of controversy. He puts forward his suggestions as difficulties, but he will not stand by them as doctrines. And this is in accordance with his general tendency; for any of his hypotheses, if insisted upon as positive theories, would be found inconsistent with the assertion of uniformity. For example, the nebular hypothesis appears to give to the history of the heavens an aspect which obliterates all special acts of creation, for, according to that hypothesis, new planetary systems are constantly forming; but when asserted as the origin of our own solar system, it brings with it an original incandescence, and an origin of the organic world. And if, instead of using the chemical theory of subterraneous heat to neutralize the evidence of original incandescence, we assert it as a positive tenet, we

can no longer maintain the infinite past duration of the earth; for chemical forces, as well as mechanical, tend to equilibrium; and that condition once attained, their efficacy ceases. Chemical affinities tend to form new compounds; and though, when many and various elements are mingled together, the play of synthesis and analysis may go on for a long time, it must at last end. If, for instance, a large portion of the earth's mass were originally pure potassium, we can imagine violent igneous action to go on so long as any part remained unoxidized; but when the oxidation of the whole has once taken place, this action must be at an end; for there is in the hypothesis no agency which can reproduce the deoxidized metal. Thus a perpetual motion is impossible in chemistry, as it is in mechanics; and a theory of constant change continued through infinite time, is untenable when asserted upon chemical, no less than upon mechanical principles. And thus the scepticism of the uniformitarian is of force only so long as it is employed against the dogmatism of the catastrophist. When the doubts are erected into dogmas, they are no longer consistent with the tenet of uniformity. When the negations become affirmations, the negation of an origin vanishes also.

6. *Uniformity in the Organic World.*—In speaking of the violent and sudden changes which constitute catastrophes, our thoughts naturally turn at

first to great *mechanical* and *physical* effects;—ruptures and displacements of strata; extensive submersions and emersions of land; rapid changes of temperature. But the catastrophes which we have to consider in geology affect the *organic* as well as the inorganic world. The sudden extinction of one collection of species, and the introduction of another in their place, is a catastrophe, even if unaccompanied by mechanical violence. Accordingly, the antagonism of the catastrophist and uniformitarian school has shown itself in this department of the subject, as well as in the other. When geologists had first discovered that the successive strata are each distinguished by appropriate organic fossils, they assumed at once that each of these collections of living things belonged to a separate creation. But this conclusion, as I have already said, Mr. Lyell has attempted to invalidate, by proving that in the existing order of things, some species become extinct; and by suggesting it as possible, that in the same order it may be true that new species are from time to time produced, even in the present course of nature. And in this, as in the other part of the subject, he calls in the aid of vast periods of time, in order that the violence of the changes may be softened down: and he appears disposed to believe that the actual extinction and creation of species may be so slow as to excite no more notice than

it has hitherto obtained; and yet may be rapid enough, considering the immensity of geological periods, to produce such a succession of different collections of species as we find in the strata of the earth's surface.

7. *Origin of the present Organic World.*—The last great event in the history of the vegetable and animal kingdoms was that by which their various tribes were placed in their present seats. And we may form various hypotheses with regard to the sudden or gradual manner in which we may suppose this distribution to have taken place. We may assume that at the beginning of the present order of things, a stock of each species was placed in the vegetable or animal *province* to which it belongs, by some cause out of the common order of nature; or we may take a uniformitarian view of the subject, and suppose that the provinces of the organic world derived their population from some anterior state of things by the operation of natural causes.

Nothing has been pointed out in the existing order of things which has any analogy or resemblance, of any valid kind, to that creative energy which must be exerted in the production of a new species. And to assume the introduction of new species as a part of the order of nature, without pointing out any natural fact with which such an event can be classed, would be to reject creation

by an arbitrary act. Hence, even on natural grounds, the most intelligible view of the history of the animal and vegetable kingdoms seems to be, that each period which is marked by a distinct collection of species forms a cycle; and that at the beginning of each such cycle a creative power was exerted, of a kind to which there was nothing at all analogous in the succeeding part of the same cycle. If it be urged that in some cases the same species, or the same genus, runs through two geological formations, which must, on other grounds, be referred to different cycles of creative energy, we may reply that the creation of many new species does not imply the extinction of all the old ones.

Thus we are led by our reasonings to this view, that the present order of things was commenced by an act of creative power entirely different to any agency which has been exerted since. None of the influences which have modified the present races of animals and plants since they were placed in their habitations on the earth's surface can have had any efficacy in producing them at first. We are necessarily driven to assume, as the beginning of the present cycle of organic nature, an event not included in the course of nature. And we may remark that this necessity is the more cogent, precisely because other cycles have preceded the present.

8. *Nebular Origin of the Solar System.*—If we

attempt to apply the same antithesis of opinion (the doctrines of catastrophe and uniformity,) to the other subjects of palætiological science, we shall be led to similar conclusions. Thus if we turn our attention to astronomical palætiology, we perceive that the nebular hypothesis has a uniformitarian tendency. According to this hypothesis the formation of this our system of sun, planets, and satellites, was a process of the same kind as those which are still going on in the heavens. One after another, nebulæ condense into separate masses, which begin to revolve about each other by mechanical necessity, and form systems of which our solar system is a finished example. But we may remark, that the uniformitarian doctrine on this subject rests on most unstable foundations. We have as yet only very vague and imperfect reasonings to show that by such condensation a *material* system such as ours could result; and the introduction of *organized* beings into such a material system is utterly out of the reach of our philosophy. Here again, therefore, we are led to regard the present order of the world as pointing towards an origin altogether of a different kind from anything which our material science can grasp.

9. *Origin of Languages.*—We may venture to say that we should be led to the same conclusion once more, if we were to take into our consideration

those palætiological sciences which are beyond the domain of matter; for instance, the history of languages. We may explain many of the differences and changes which we become acquainted with, by referring to the action of causes of change which still operate. But what glossologist will venture to declare that the efficacy of such causes has been uniform; that the influences which mould a language, or make one language differ from others of the same stock, operated formerly with no more efficacy than they exercise now. "Where," as has elsewhere been asked, "do we now find a language in the process of formation, unfolding itself in inflexions, terminations, changes of vowels by grammatical relations, such as characterize the oldest known languages?" Again, as another proof how little the history of languages suggests to the philosophical glossologist the persuasion of a uniform action of the causes of change, I may refer to the conjecture of Dr. Prichard, that the varieties of language produced by the separation of one stock into several, have been greater and greater as we go backwards in history:—that* the formation of sister dialects from a common language, (as the Scandinavian, German, and Saxon dialects from the Teutonic, or the Gaelic, Erse and Welsh from the

* *Researches*, II., 224.

Celtic,) belongs to the first millennium before the Christian era; while the formation of cognate languages of the same family, as the Sanskrit, Latin, Greek and Gothic, must be placed at least two thousand years before that era; and at a still earlier period took place the separation of the great families themselves, the Indo-European, Semitic, and others, in which it is now difficult to trace the features of a common origin. No hypothesis except one of this kind will explain the existence of the families, groups, and dialects of languages, which we find in existence. Yet this is an entirely different view from that which the hypothesis of the uniform progress of change would give. And thus in the earliest stages of man's career, the revolutions of language must have been, even by the evidence of the theoretical history of language itself, of an order altogether different from any which have taken place within the recent history of man. And we may add, that as the early stages of the progress of language must have been widely different from those later ones of which we can in some measure trace the natural causes, we cannot place the origin of language in any point of view in which it comes under the jurisdiction of natural causation at all.

10. *No Natural Origin discoverable.*—We are thus led by a survey of several of the palætiological sciences to a confirmation of the principle formerly

asserted*, That in no palætiological science has man been able to arrive at a beginning which is homogeneous with the known course of events. We can in such sciences often go very far back;—determine many of the remote circumstances of the past series of events;—ascend to a point which seems to be near the origin;—and limit the hypotheses respecting the origin itself:—but philosophers never have demonstrated, and, so far as we can judge, probably never will be able to demonstrate, what was that primitive state of things from which the progressive course of the world took its first departure. In all these paths of research, when we travel far backwards, the aspect of the earlier portions becomes very different from that of the advanced part on which we now stand; but in all cases the path is lost in obscurity as it is traced backwards towards its starting point:—it becomes not only invisible, but unimaginable; it is not only an interruption, but an abyss, which interposes itself between us and any intelligible beginning of things.

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* *Hist. Ind. Sci.*, III., 581.

RELATION OF TRADITION TO PALÆTIOLOGY.

1. *Importance of Tradition.*—Since the Palætiological Sciences have it for their business to study the train of past events produced by natural causes down to the present time, the knowledge concerning such events which is supplied by the remembrance and records of man, in whatever form, must have an important bearing upon these sciences. All changes in the condition and extent of land and sea, which have taken place within man's observation, all effects of deluges, sea-waves, rivers, springs, volcanos, earthquakes, and the like, which come within the reach of human history, have a strong interest for the palætiologist. Nor is he less concerned in all recorded instances of the modification of the forms and habits of plants and animals, by the operations of man, or by transfer from one land to another. And when we come to the Palætiology of Language, of Art, of Civilization, we find our subject still more closely connected with history; for in truth these are historical, no less than palætiological investigations. But, confining ourselves at present to the material sciences, we may observe that though the importance of the information which tradition gives us, in the sciences now under our consideration, as, for instance geology, has long been tacitly recognised; yet it is only recently that geologists have em-

ployed themselves in collecting their historical facts upon such a scale and with such comprehensive views as are required by the interest and use of collections of this kind. The Essay of Von Hoff*, *On the Natural Alterations in the Surface of the Earth which are proved by Tradition*, was the work which first opened the eyes of geologists to the extent and importance of this kind of investigation. Since that time the same path of research has been pursued with great perseverance by others, especially by Mr. Lyell; and is now justly considered as an essential portion of geology.

2. *Connexion of Tradition and Science.*—Events which we might naturally expect to have some bearing on geology, are recorded in the historical writings which, even on mere human grounds, have the strongest claim to our respect as records of the early history of the world, and are confirmed by the traditions of various nations all over the globe, namely, the formation of the earth and its population, and a subsequent deluge. It has been made a matter of controversy how the narrative of these events is to be understood, so as to make it agree with the facts which an examination of the earth's surface and of its vegetable and animal population discloses to us. Such controversies, when they are

* Vol I., 1822; Vol. II., 1824.

considered as merely archæological, may occur in any of the palætiological sciences. We may have to compare and to reconcile the evidence of existing phenomena with that of historical tradition. But under some circumstances this process of conciliation may assume an interest of another kind, on which we will make a few remarks.

3. *Natural and Providential History of the World.*—We may contemplate the existence of man upon the earth, his origin and his progress, in the same mannner as we contemplate the existence of any other race of animals; namely, in a purely palætiological view. We may consider how far our knowledge of laws of causation enables us to explain his diffusion and migration, his differences and resemblances, his actions and works. And this is the view of man as a member of the *natural* course of things.

But man, at the same time the contemplator and the subject of his own contemplation, endowed with faculties and powers, which make him a being of a different nature from other animals, cannot help regarding his own actions and enjoyments, his recollections and his hopes, under an aspect quite different from any that we have yet had presented to us. We have been endeavouring to place in a clear light the Fundamental Ideas, such as that of Cause, on which depends our knowledge

of the natural course of things. But there are other Ideas to which man necessarily refers his actions; he is led by his nature, not only to consider his own actions, and those of his fellow-men, as springing out of this or that cause, leading to this or that material result; but also as good or bad, as what they ought or ought not to be. He has Ideas of *moral* relations as well as those Ideas of material relations with which we have hitherto been occupied. He is a moral as well as a natural agent.

Contemplating himself and the world around him by the light of his Moral Ideas, man is led to the conviction that his moral faculties were bestowed upon him by design and for a purpose; that he is the subject of a moral government; that the course of the world is directed by the Power which governs it, to the unfolding and perfecting of man's moral nature; that this guidance may be traced in the career of individuals and of the world; that there is a *providential* as well as a natural course of things.

Yet this view is beset by no small difficulties. The full developement of man's moral faculties;—the perfection of his nature up to the measure of his own ideas;—the adaptation of his moral being to an ultimate destination, by its transit through a world full of moral evil, in which each has his

share;—are effects for which the economy of the world appears to contain no adequate provision. Man, though aware of his moral nature, and ready to believe in an ultimate destination of purity and blessedness, is too feeble to resist the temptation of evil, and to restore his purity when once lost. He cannot but look for some confirmation of that providential order which he has begun to believe; some provision for those deficiencies in his moral condition which he has begun to feel.

He looks at the history of the world, and he finds that at a certain period it offers to him the promise of what he seeks. When the natural powers of man had been developed to their full extent, and were beginning to exhibit symptoms of decay; when the intellectual progress of the world appeared to have reached its limit, without supplying man's moral needs; we find the great Epoch in the Providential history of the world. We find the announcement of a Dispensation by which man's deficiencies shall be supplied and his aspirations fulfilled: we find a provision for the purification, the support, and the ultimate beatification of those who use the provided means. And thus the providential course of the world becomes consistent and intelligible.

4 *The Sacred Narrative.*—But with the new Dispensation, we receive, not only an account of

its own scheme and history, but also a written narrative of the providential course of the world from the earliest times, and even from its first creation. This narrative is recognized and authorized by the new dispensation, and accredited by some of the same evidences as the dispensation itself. That the existence of such a sacred narrative should be a part of the providential order of things, cannot but appear natural; but naturally also, the study of it leads to some difficulties.

The Sacred Narrative in some of its earliest portions speaks of natural objects and occurrences respecting them. In the very beginning of the course of the world, we may readily believe (indeed, as we have seen in the last chapter, our scientific researches lead us to believe) that such occurrences were very different from anything which now takes place;—different to an extent and in a manner which we cannot estimate. Now the narrative must speak of objects and occurrences in the words and phrases which have derived their meaning from their application to the existing natural state of things. When applied to an initial supernatural state therefore, these words and phrases cannot help being to us obscure and mysterious, perhaps ambiguous and seemingly contradictory.

5. *Difficulties in interpreting the Sacred Narrative.*—The moral and providential relations of

man's condition are so much more important to him than mere natural relations, that at first we may well suppose he will accept the Sacred Narrative, as not only unquestionable in its true import, but also as a guide in his views even of mere natural relations. He will try to modify the conceptions which he entertains of objects and their properties, so that the Sacred Narrative of the supernatural condition shall retain the first meaning which he had put upon it in virtue of his own habits in the usage of language.

But man is so constituted that he cannot persist in this procedure. The powers and tendencies of his intellect are such that he cannot help trying to attain true conceptions of objects and their properties by the study of things themselves. For instance, when he at first read of a firmament dividing the waters above from the waters below, he perhaps conceived a transparent floor in the skies, on which the superior waters rested which descend in rain; but as his observations and his reasonings satisfied him that such a floor could not exist, he became willing to allow (as St. Augustin allowed) that the waters above the firmament are in a state of vapour. And in like manner in other subjects, men, as their views of nature became more distinct and precise, modified, so far as it was neces-

sary for consistency's sake, their first rude interpretations of the Sacred Narrative; so that, without in any degree losing its import as a view of the providential course of the world, it should be so conceived as not to contradict what they knew of the natural order of things.

But this accommodation was not always made without painful struggles and angry controversies. When men had conceived the occurrences of the Sacred Narrative in a particular manner, they could not readily and willingly adopt a new mode of conception; and they resisted all attempts to recommend it to them, as attacks upon the sacredness of the Narrative. They had clothed their belief of the workings of Providence in certain images; and they clung to those images with the persuasion that without them their belief could not subsist. Thus they imagined to themselves that the earth was a flat floor, solidly and broadly laid for the convenience of man, and they felt as if the kindness of Providence was disparaged, when it was maintained that the earth was a globe held together only by the mutual attraction of its parts.

The most memorable instance of a struggle of this kind is to be found in the circumstances which attended the introduction of the Heliocentric Theory of Copernicus to general acceptance. On this con-

troversy I have already made some remaks in the History of Science*, and have attempted to draw from it some lessons which may be useful to us when any similar conflict of opinions may occur. I will here add a few reflections with a similar view.

6. *Such difficulties inevitable.*—In the first place, I remark that such modifications of the current interpretation of the words of Scripture appear to be an inevitable consequence of the progressive character of Natural Science. Science is constantly teaching us to describe known facts in new language, but the language of Scripture is always the same. And not only so, but the language of Scripture is necessarily adapted to the common state of man's intellectual developement, in which he is supposed not to be possessed of science. Hence the phrases used by Scripture are precisely those which science soon teaches man to consider as inaccurate. Yet they are not on that account the less fitted for their proper purpose: for if any terms had been used, adapted to a more advanced state of knowledge, they must have been unintelligible among those to whom the Scripture was first addressed. If the Jews had been told that water existed in the clouds in small drops, they would have marvelled

* *Hist. Ind. Sci.*, I., 401.

that it did not constantly descend; and to have explained the reason of this, would have been to teach Atmology in the sacred writings. If they had read in their Scripture that the earth was a sphere, when it appeared to be a plain, they would only have been disturbed in their thoughts, or driven to some wild and baseless imaginations by a declaration to them so strange. If the Divine Speaker, instead of saying that he would set his bow in the clouds, had been made to declare that he would give to water the property of refracting different colours at different angles, how utterly unmeaning to the hearers would the words have been! And in these cases, the expressions, being unintelligible, startling, and bewildering, would have been such as tended to unfit the Sacred Narrative for its place in the providential dispensation of the world.

Accordingly, in the great controversy which took place in Galileo's time between the defenders of the then customary interpretations of Scripture, and the assertors of the Copernican system of the universe, when the innovators were upbraided with maintaining opinions contrary to Scripture, they replied that Scripture was not intended to teach men astronomy, and that it expressed the acts of divine power in images which were suited to the ideas of unscientific men. To speak of the rising and set-

ting and travelling of the sun, of the fixity and of the foundations of the earth, was to use the only language which would have made the Sacred Narrative intelligible. To extract from these and the like expressions doctrines of science, was, they declared, in the highest degree unjustifiable; and such a course could lead, they held, to no result but a weakening of the authority of Scripture in proportion as its credit was identified with that of these modes of applying it. And this judgment has since been generally assented to by those who most reverence and value the study of the designs of Providence as well as that of the works of nature.

7. *Science tells us nothing concerning Creation.* —Other apparent difficulties arise from the accounts given in the Scripture of the first origin of the world in which we live: for example, light is represented as created before the sun. With regard to difficulties of this kind, it appears that we may derive some instruction from the result to which we were led in the last chapter;—namely, that in the sciences which trace the progress of natural occurrences, we can in no case go back to an origin, but in every instance appear to find ourselves separated from it by a state of things, and an order of events, of a kind altogether different from those which come under our experience. The thread of induction respecting the natural course of the world

snaps in our fingers, when we try to ascertain where its beginning is. Since, then, science can teach us nothing positive respecting the beginning of things, she can neither contradict nor confirm what is taught by Scripture on that subject; and thus, as it is unworthy timidity to fear contradiction, so is it ungrounded presumption to look for confirmation in such cases. The providential history of the world has its own beginning, and its own evidence; and we can only render the system insecure, by making it lean on our material sciences. If any one were to suggest that the nebular hypothesis countenances the Scripture history of the formation of this system, by showing how the luminous matter of the sun might exist previous to the sun itself, we should act wisely in rejecting such an attempt to weave together these two heterogeneous threads;—the one a part of a providential scheme, the other a fragment of physical speculation.

We shall best learn those lessons of the true philosophy of science which it is our object to collect, by attending to portions of science which have gone through such crises as we are now considering; nor is it requisite, for this purpose, to bring forwards any subjects which are still under discussion. It may, however, be mentioned that such maxims as we are now endeavouring to establish, and the one before us in particular, bear with a

peculiar force upon those Palætiological Sciences of which we have been treating in the present Book.

8. *Scientific views, when familiar, do not disturb the authority of Scripture.*—There is another reflection which may serve to console and encourage us in the painful struggles which thus take place, between those who maintain interpretations of Scripture already prevalent and those who contend for such new ones as the new discoveries of science require. It is this;—that though the new opinion is resisted by one party as something destructive of the credit of Scripture and the reverence which is its due, yet, in fact, when the new interpretation has been generally established and incorporated with men's current thoughts, it ceases to disturb their views of the authority of the Scripture or of the truth of its teaching. When the language of Scripture, invested with its new meaning, has become familiar to men, it is found that the ideas which it calls up are quite as reconcileable as the former ones were with the most entire acceptance of the providential dispensation. And when this has been found to be the case, all cultivated persons look back with surprise at the mistake of those who thought that the essence of the revelation was involved in their own arbitrary version of some collateral circumstance in the revealed narrative. At

the present day, we can hardly conceive how reasonable men could ever have imagined that religious reflections on the stability of the earth, and the beauty and use of the luminaries which revolve round it, would be interfered with by an acknowledgement that this rest and motion are apparent only*. And thus the authority of revelation is not shaken by any changes introduced by the progress of science in the mode of interpreting expressions which describe physical objects and occurrences; provided the new interpretation is admitted at a proper season, and in a proper spirit; so as to soften, as much as possible, both the public controversies and the private scruples which almost inevitably accompany such an alteration.

9. *When should old Interpretations be given up?* —But the question then occurs, What is the proper season for a religious and enlightened commentator to make such a change in the current interpretation of sacred Scripture? At what period ought the established exposition of a passage to be given up, and a new mode of understanding the passage, such as is, or seems to be, required by new discoveries respecting the laws of nature, accepted in its place? It is plain, that to introduce such an alteration lightly and hastily would be a procedure

* I have here borrowed a sentence or two from my own History.

fraught with inconvenience; for if the change were made in such a manner, it might be afterwards discovered that it had been adopted without sufficient reason, and that it was necessary to reinstate the old exposition. And the minds of the readers of Scripture, always to a certain extent and for a time disturbed by the subversion of their long-established notions, would be distressed without any need, and might be seriously unsettled. While, on the other hand, a too protracted and obstinate resistance to the innovation, on the part of the scriptural expositors, would tend to identify, at least in the minds of many, the authority of the Scripture with the truth of the exposition; and therefore would bring discredit upon the revealed word, when the established interpretation was finally proved to be untenable.

A rule on this subject, propounded by some of the most enlightened dignitaries of the Roman Catholic church, on the occasion of the great Copernican controversy begun by Galileo, seems well worthy of our attention. The following was the opinion given by Cardinal Bellarmine at the time: —"When a *demonstration* shall be found to establish the earth's motion, it will be proper to interpret the sacred Scriptures otherwise than they have hitherto been interpreted in those passages where mention is made of the stability of the earth and

movement of the heavens." This appears to be a judicious and reasonable maxim for such cases in general. So long as the supposed scientific discovery is doubtful, the exposition of the meaning of Scripture given by commentators of established credit is not wantonly to be disturbed: but when a scientific theory, irreconcileable with this ancient interpretation, is clearly proved, we must give up the interpretation, and seek some new mode of understanding the passage in question, by means of which it may be consistent with what we know; for if it be not, our conception of the things so described is no longer consistent with itself.

It may be said that this rule is indefinite, for who shall decide when a new theory is completely demonstrated, and the old interpretation become untenable? But to this we may reply, that if the rule be assented to, its application will not be very difficult. For when men have admitted as a general rule, that the current interpretations of scriptural expressions respecting natural objects and events may possibly require, and in some cases certainly will require, to be abandoned, and new ones admitted, they will hardly allow themselves to contend for such interpretations as if they were essential parts of revelation; and will look upon the change of exposition, whether it come sooner or later, without alarm or anger. And when men lend them-

selves to the progress of truth in this spirit, it is not of any material importance at what period a new and satisfactory interpretation of the scriptural difficulty is found; since a scientific exactness in our apprehension of the meaning of such passages as are now referred to is very far from being essential to our full acceptance of revelation.

10. *In what Spirit should the Change be accepted?*—Still these revolutions in scriptural interpretation must always have in them something which distresses and disturbs religious communities. And such uneasy feelings will take a different shape, according as the community acknowledges or rejects a paramount interpretative authority in its religious leaders. In the case in which the interpretation of the Church is binding upon all its members, the more placid minds rest in peace upon the ancient exposition, till the spiritual authorities announce that the time for the adoption of a new view has arrived; but in these circumstances, the more stirring and inquisitive minds, which cannot refrain from the pursuit of new truths and exact conceptions, are led to opinions which, being contrary to those of the Church, are held to be sinful. On the other hand, if the religious constitution of the community allow and encourage each man to study and interpret for himself the Sacred Writings, we are met by evils of another kind. In this case, although, by the

unforced influence of admired commentators, there may prevail a general agreement in the usual interpretation of difficult passages, yet as each reader of the Scripture looks upon the sense which he has adopted as being his own interpretation, he maintains it, not with the tranquil acquiescence of one who has deposited his judgment in the hands of his Church, but with the keenness and strenuousness of self-love. In such a state of things, though no judicial severities can be employed against the innovators, there may arise more angry controversies than in the other case.

It is impossible to overlook the lesson which here offers itself, that it is in the highest degree unwise in the friends of religion, whether individuals or communities, unnecessarily to embark their credit in expositions of Scripture on matters which appertain to natural science. By delivering physical doctrines as the teaching of revelation, religion may lose much, but cannot gain anything. This maxim of practical wisdom has often been urged by Christian writers. Thus St. Augustin says*: "In obscure matters and things far removed from our senses, if we read anything, even in the divine Scripture, which may produce diverse opinions without damaging the faith which we cherish, let us not rush

* Lib. 1. *de Genesi*, cap. xviii.

headlong by positive assertion to either the one opinion or the other; lest, when a more thorough discussion has shown the opinion which we had adopted to be false, our faith may fall with it: and we should be found contending, not for the doctrine of the sacred Scriptures, but for our own; endeavouring to make our doctrine to be that of the Scriptures, instead of taking the doctrine of the Scriptures to be ours." And in nearly the same spirit, at the time of the Copernican controversy, it was thought proper to append to the work of Copernicus a postil, to say that the work was written to account for the phenomena, and that people must not run on blindly and condemn either of the opposite opinions. Even when the Inquisition, in 1616, thought itself compelled to pronounce a decision upon this subject, the verdict was delivered in very moderate language;—that "the doctrine of the earth's motion appeared to be contrary to Scripture:" and yet, moderate as this expression is, it has been blamed by judicious members of the Roman church as deciding a point such as religious authorities ought not to pretend to decide; and has brought upon that church no ordinary weight of general condemnation. Kepler pointed out, in his lively manner, the imprudence of employing the force of religious authorities on such subjects: *Acies dolabræ in ferrum illisa, postea nec*

in lignum valet amplius. Capiat hoc cujus interest. "If you *will* try to chop iron, the axe becomes unable to cut even wood."

11. *In what Spirit should the Change be urged?*—But while we thus endeavour to show in what manner the interpreters of Scripture may most safely and most properly accept the discoveries of science, we must not forget that there may be errors committed on the other side also; and that men of science, in bringing forward views which may for a time disturb the minds of lovers of Scripture, should consider themselves as bound by strict rules of candour, moderation, and prudence. Intentionally to make their supposed discoveries a means of discrediting, contradicting, or slighting the sacred Scriptures, or the authority of religion, is in them unpardonable. As men who make the science of Truth the business of their lives, and are persuaded of her genuine superiority, and certain of her ultimate triumph, they are peculiarly bound to urge her claims in a calm and temperate spirit; not forgetting that there are other kinds of truth besides that which they peculiarly study. They may properly reject authority in matters of science; but they are to leave it its proper office in matters of religion. I may here again quote Kepler's expressions: "In Theology we balance authorities, in Philosophy we weigh reasons. A holy man was Lactantius

who denied that the earth was round; a holy man was Augustin, who granted the rotundity, but denied the antipodes; a holy thing to me is the Inquisition, which allows the smallness of the earth, but denies its motion; but more holy to me is Truth; and hence I prove, from philosophy, that the earth is round, and inhabited on every side, of small size, and in motion among the stars,—and this I do with no disrespect to the Doctors." I the more willingly quote such a passage from Kepler, because the entire ingenuousness and sincere piety of his character does not allow us to suspect in him anything of hypocrisy or latent irony. That similar professions of respect may be made ironically, we have a noted example in the celebrated Introduction to *Galileo's Dialogue on the Copernican System;* probably the part which was most offensive to the authorities. "Some years ago," he begins, "a wholesome edict was promulgated at Rome, which, in order to check the perilous scandals of the present age, imposed silence upon the Pythagorean opinion of the mobility of the earth. There were not wanting," he proceeds, "persons who rashly asserted that this decree was the result, not of a judicious inquiry, but of passion ill-informed; and complaints were heard that counsellors, utterly unacquainted with astronomical observation, ought not to be allowed, with their sudden prohibitions, to clip the wings of speculative intellects. *At the*

hearing of rash lamentations like these, my zeal could not keep silence." And he then goes on to say, that he wishes, in his *Dialogue*, to show that the subject had been fully examined at Rome. Here the irony is quite transparent, and the sarcasm glaringly obvious. I think we may venture to say that this is not the temper in which scientific questions should be treated; although by some, perhaps, the prohibition of public discussion may be considered as justifying any evasion which is likely to pass unpunished.

12. *Duty of Mutual Forbearance.*—We may add, as a further reason for mutual forbearance in such cases, that the true interests of both parties are the same. The man of science is concerned, no less than any other person, in the truth and import of the divine dispensation; the religious man, no less than the man of science, is, by the nature of his intellect, incapable of believing two contradictory declarations. Hence they have both alike a need for understanding the Scripture in some way in which it shall be consistent with their understanding of nature. It is for their common advantage to conciliate, as Kepler says, the finger and the tongue of God, his works and his word. And they may find abundant reason to bear with each other, even if they should adopt for this purpose different interpretations, each finding one satisfactory to himself;

or if any one should decline employing his thoughts on such subjects at all. I have elsewhere* quoted a passage from Kepler† which appears to me written in a most suitable spirit: "I beseech my reader that, not unmindful of the Divine goodness bestowed upon man, he do with me praise and celebrate the wisdom of the Creator, which I open to him from a more inward explication of the form of the world, from a searching of causes, from a detection of the errors of vision; and that thus, not only in the firmness and stability of the earth may we perceive with gratitude the preservation of all living things in nature as the gift of God: but also that in its motion, so recondite, so admirable, we may acknowledge the wisdom of the Creator. But whoever is too dull to receive this science, or too weak to believe the Copernican system without harm to his piety, him, I say, I advise that, leaving the school of astronomy, and condemning, if so he please, any doctrines of the philosophers, he follow his own path, and desist from this wandering through the universe; and that, lifting up his natural eyes, with which alone he can see, he pour himself out from his own heart in worship of God the Creator, being certain that he gives no less worship to God than the astronomer, to whom God has given to see more

* *Bridgewater Tr.* p. 314. † *Com. Stell. Mart.* Introd.

clearly with his inward eyes, and who, from what he has himself discovered, both can and will glorify God."

13. *Case of Galileo.*—I may perhaps venture here to make a remark or two upon this subject with reference to a charge brought against a certain portion of the *History of the Inductive Sciences.* (p. 2 of this). Complaint has been made* that the character of the Roman church, as shown in its behaviour towards Galileo, is misrepresented in the account given of it in the History of Astronomy. It is asserted that Galileo provoked the condemnation he incurred; first, by pertinaciously demanding the assent of the ecclesiastical authorities to his opinion of the consistency of the Copernican doctrine with Scripture; and afterwards by contumaciously, and, as we have seen, contumeliously violating the silence which the Church had enjoined upon him. It is further declared that the statement which represents it as the habit of the Roman church to dogmatize on points of natural science is unfounded; as well as the opinion that in consequence of this habit, new scientific truths were promulgated less boldly in Italy than in other countries. I shall reply very briefly on these subjects; for the decision of them is by no means requisite in order to establish the doctrines

* *Dublin Review*, No. IX. July, 1838. p. 72.

to which I have been led in the present chapter, nor, I hope, to satisfy my reader that my views have been collected from an impartial consideration of scientific history.

With regard to Galileo, I do not think it can be denied that he obtruded his opinions upon the ecclesiastical authorities in an unnecessary and imprudent manner. He was of an ardent character, strongly convinced himself, and urged on still more by the conviction which he produced among his disciples, and thus he became impatient for the triumph of truth. This judgment of him has recently been delivered by various independent authorities, and has undoubtedly considerable foundation*. As to the question whether authority in matters of natural science were habitually claimed by the authorities of the Church of Rome, I have to allow that I cannot produce instances which establish such a habit. We who have been accustomed to have daily before our eyes the Monition which the Romish editors of Newton thought it necessary to prefix—*Cæterum latis a summo Pontifice contra telluris motum*

* Besides the *Dublin Review*, I may quote the *Edinburgh Review*, which I suppose will not be thought likely to have a bias in favour of the exercise of ecclesiastical authority in matters of science: "Galileo contrived to surround the truth with every variety of obstruction. The tide of knowledge, which had hitherto advanced in peace, he crested with angry breakers, and he involved in its surf both his friends and his foes."—*Ed. Rev.* No. cxxiii. p. 126.

Decretis, nos obsequi profitemur—were not likely to conjecture that this was a solitary instance of the interposition of the Papal authority on such subjects. But although it would be easy to find declarations of heresy delivered by Romish Universities, and writers of great authority, against tenets belonging to the natural sciences, I am not aware that any other case can be adduced in which the Church or the Pope can be shown to have pronounced such a sentence. I am well contented to acknowledge this; for I should be far more gratified by finding myself compelled to hold up the seventeeth century as a model for the nineteenth in this respect, than by having to sow enmity between the admirers of the past and the present through any disparaging contrast*.

With respect to the attempt made in my History to characterize the intellectual habits of Italy as produced by her religious condition,—certainly it would ill become any student of the history of science to speak slightingly of that country, always the mother of sciences, always ready to

* I may add that the most candid of the adherents of the Church of Rome condemn the assumption of authority in matters of science, made, in this one instance at least, by the ecclesiasticel tribunals. The author of the *Ages of Faith* (Book VIII. p. 248), says, "A Congregation, it is to be lamented, declared the new system to be opposed to Scripture, and therefore heretical."

catch the dawn and hail the rising of any new light of knowledge. But I think our admiration of this activity and acuteness of mind is by no means inconsistent with the opinion, that new truths were promulgated more boldly beyond the Alps, and that the subtilty of the Italian intellect loved to insinuate what the rough German bluntly asserted. Of the decent duplicity with which forbidden opinions were handled, the reviewer himself gives us instances, when he boasts of the liberality with which Copernican professors were placed in important stations by the ecclesiastical authorities, soon after the doctrine of the motion of the earth had been declared by the same authorities contrary to Scripture. And in the same spirit is the process of demanding from Galileo a public and official recantation of opinions which he had repeatedly been told by his ecclesiastical superiors he might hold as much as he pleased. I think it is easy to believe that among persons so little careful to reconcile public profession with private conviction, official decorum was all that was demanded. When Galileo had made his renunciation of the earth's motion on his knees, he rose and said, as we are told, *E pur si muove*—"and yet it *does* move." This is sometimes represented as the heroic soliloquy of a mind cherishing its conviction of the truth, in spite of persecution; I think we may more naturally conceive it uttered as a playful epigram

in the ear of a cardinal's secretary, with a full knowledge that it would be immediately repeated to his master.

Besides the Ideas involved in the material sciences, of which we have already examined the principle ones, there is one Idea or Conception which our Sciences do not indeed include, but to which they not obscurely point; and the importance of this Idea will make it proper to speak of it, though this must be done very briefly.

OF THE CONCEPTION OF A FIRST CAUSE.

1. At the end of the last chapter (p. 122), we were led to this result,—that we cannot, in any of the Palætiological Sciences, ascend to a beginning which is of the same nature as the existing cause of events, and which depends upon causes that are still in operation. Philosophers never have demonstrated, and probably never will be able to demonstrate, what was the original condition of the solar system, of the earth, of the vegetable and animal worlds, of languages, of arts. On all these subjects the course of investigation, followed backwards as far as our materials allow us to pursue it, ends at last in an impenetrable gloom. We strain our eyes in vain when we try, by our natural faculties, to discern an Origin.

2. Yet speculative men have been constantly employed in attempts to arrive at that which thus seems to be placed out of their reach. The Origin of Languages, the Origin of the present Distribution of Plants and Animals, the Origin of the Earth, have been common subjects of diligent and persevering inquiry. Indeed inquiries respecting such subjects have been, at least till lately, the usual form which Palætiological researches have assumed. *Cosmogony*, the origin of the world, of which, in such speculations, the earth was considered as a principal part, has been a favourite study both of ancient and of modern times: and most of the attempts at Geology previous to the present period have been *Cosmogonies* or *Geogonies*, rather than that more genuine science which we have endeavoured to delineate. Glossology, though now an extensive body of solid knowledge, was mainly brought into being by inquiries concerning the original language spoken by men; and the nature of the first separation and diffusion of languages, the first peopling of the earth by man and by animals, were long sought after with ardent curiosity, although of course with reference to the authority of the Scriptures, as well as the evidence of natural phenomena. Indeed the interest of such inquiries even yet is far from being extinguished. The disposition to explore the past in the hope

of finding, by the light of natural reasoning as well as by the aid of revelation, the origin of the present course of things, appears to be unconquerable. What was the beginning? is a question which the human race cannot desist from perpetually asking. And no failure in obtaining a satisfactory answer can prevent inquisitive spirits from again and again repeating the inquiry, although the blank abyss into which it is uttered does not even return an echo.

3. What, then, is the reason of an attempt so pertinacious yet so fruitless? By what motive are we impelled thus constantly to seek what we can never find? Why are the error of our conjectures, the futility of our reasonings, the precariousness of our interpretations, over and over again proved to us in vain? Why is it impossible for us to acquiesce in our ignorance and to relinquish the inquiry? Why cannot we content ourselves with examining those links of the chain of causes which are nearest to us;—those in which the connexion is intelligible and clear; instead of fixing our attention upon those remote portions where we can no longer estimate its coherence? In short, why did not men from the first take for the subject of their speculations the Course of Nature rather than the Origin of Things?

To this we reply, that in doing what they

have thus done, in seeking what they have sought, men are impelled by an intellectual necessity. They cannot conceive a series of connected occurrences without a commencement; they cannot help supposing a cause for the whole, as well as a cause for each part; they cannot be satisfied with a succession of causes without assuming a First Cause. Such an assumption is necessarily impressed upon our minds by our contemplation of a series of causes and effects; that *there must be a First Cause*, is accepted by all intelligent reasoners as an Axiom: and like other Axioms, its truth is necessarily implied in the Idea which it involves.

4. The evidence of this axiom may be illustrated in several ways. In the first place, the axiom is assumed in the argument usually offered to prove the existence of the Deity. Since, it is said, the world now exists, and since nothing cannot produce something, something must have existed from eternity. This Something is the First Cause: it is God.

Now what I have to remark here is this: the conclusiveness of this argument, as a proof of the existence of one independent, immutable Deity, depends entirely upon the assumption of the axiom above stated. The world, a series of causes and effects, exists: therefore there must be, not only this series of causes and effects, but also a First

Cause. It will be easily seen, that without the axiom, that in every series of causes and effects there must be a First Cause, the reasoning is altogether inconclusive.

5. Or to put the matter otherwise: The argument for the existence of the Deity was stated thus: Something exists, therefore something must have existed from eternity. Granted, the opponent might say; but this *something* which has existed from eternity, why may it not be this very series of causes and effects which is now going on, and which appears to contain in itself no indication of beginning or end? And thus, without the assumption of the necessity of a First Cause, the force of the argument may be resisted.

6. But, it may be asked, how do those who have written to prove the existence of the Deity reply to such an objection as the one just stated? It is natural to suppose that, on a subject so interesting and so long discussed, all the obvious arguments, with their replies, have been fully brought into view. What is the result in this case?

The principal modes of replying to the above objection, that the series of causes and effects which now exists, may have existed from eternity, appear to be these.

In the first place, our minds cannot be satisfied with a series of successive, dependent, causes

and effects, without something first and independent. We pass from effect to cause, and from that to a higher cause, in search of something on which the mind can rest; but if we can do nothing but repeat this process, there is no use in it. We move our limbs, but make no advance. Our question is not answered, but evaded. The mind cannot acquiesce in the destiny thus presented to it, of being referred from event to event, from object to object, along an interminable vista of causation and time. Now this mode of stating the reply,—to say that the mind *cannot thus be satisfied*, appears to be equivalent to saying that the mind is conscious of a principle in virtue of which such a view as this must be rejected;—the mind takes refuge in the assumption of a First Cause, from an employment inconsistent with its own nature.

7. Or again, we may avoid the objection, by putting the argument for the existence of a Deity in this form: The series of causes and effects which we call the *world*, or the *course of nature*, may be considered as a *whole*, and this whole must have a cause of its existence. The whole collection of objects and events may be comprehended as a single effect, and of this effect there must be a cause. This Cause of the Universe must be superior to, and independent of the special events, which,

happening in time, make up the universe of which He is the cause. He must exist and exercise causation, before these events can begin: He must be the First Cause.

Although the argument is here somewhat modified in form, the substance is the same as before. For the assumption that we may consider the whole series of causes and effects as a *single effect*, is equivalent to the assumption that besides partial causes, we must have a First Cause. And thus the Idea of a First Cause, and the axiom which asserts its necessity, are recognized in the usual argumentation on this subject.

8. This Idea of a First Cause, and the principle involved in the Idea, have been the subject of discussion in another manner. As we have already said, we assume as an axiom that a First Cause must exist; and we assert that God, the First Cause, exists eternal and immutable, by the necessity which the axiom implies. Hence God is said to exist necessarily;—to be a necessarily existing being. And when this *necessary existence* of God had been spoken of, it soon began to be contemplated as a sufficient reason, and as an absolute demonstration of His existence; without any need of referring to the world as an effect, in order to arrive at God as the cause. And thus

men conceived that they had obtained a proof of the existence of the Deity, *à priori*, from ideas, as well as *à posteriori*, from effects.

9. Thus, Thomas Aquinas employs this reasoning to prove the *eternity* of God*. "Oportet ponere aliquod primum necessarium quod est per se ipsum necessarium; et hoc est Deus, cum sit prima causa ut dictum est: igitur Deus æternus est, cum omne necessarium per se sit æternum." It is true that the schoolmen never professed to be able to prove the *existence* of the Deity *à priori:* but they made use of this conception of necessary existence in a manner which approached very near to such an attempt. Thus Suarez† discusses the question, "Utrum aliquo modo possit *à priori* demonstrari Deum esse." And resolves the question in this manner: "Ad hunc ergo modum dicendum est: Demonstrato *à posteriori* Deum esse ens necessarium et a se, ex hoc attributo posse *à priori* demonstrari præter illud non posse eese aliud ens necessarium et a se, et consequenter demonstrari Deum esse."

But in modern times attempts were made by Descartes and Samuel Clarke, to prove the Divine existence at once *à priori*, from the conception of

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* Aquin. *Contr. Gentil.* Lib. I. Chap. xiv. p. 21.
† *Metaphys.* Tom. II. Disp. xxix. Sect. 3. p. 28.

necessary existence; which, it was argued, could not subsist without actual existence. This argumentation was acutely and severely criticized by Dr. Waterland.

10. Without dwelling upon a subject, the discussion of which does not enter into the design of the present work, I may remark that the question whether an *à priori* proof of the existence of a First Cause be possible, is a question concerning the nature of our Ideas, and the evidence of the axioms which they involve, of the same kind as many questions which we have already had to discuss. Is our Conception or Idea of a First Cause gathered from the effects we see around us? It is plain that we must answer, here as in other cases, that the Idea is not extracted from the phenomena, but assumed in order that the phenomena may become intelligible to the mind;—that the Idea is a necessary one, inasmuch as it does not depend upon observation for its evidence; but that it depends upon observation for its developement, since without some observation, we cannot conceive the mind to be cognisant of the relation of causation at all. In this respect, however, the Idea of a First Cause is no less necessary than the ideas of Space, or Time, or Cause in general. And whether we call the reasoning derived from such a necessity an argument *à priori*

or *à posteriori*, in either case it possesses the genuine character of demonstration, being founded upon axioms which command universal assent.

11. I have, however, spoken of our *Conception* rather than of our *Idea* of a First Cause; for the notion of a First Cause appears to be rather a modification of the Fundamental Idea of Cause, which was formerly discussed, than a separate and peculiar Idea. And the Axiom, *that there must be a First Cause*, is recognized by most persons as an application of the general Axiom of Causation, *that every effect must have a cause;* this latter Axiom being applied to the world, considered in its totality, as a single effect. This distinction, however, between an Idea and a Conception, is of no material consequence to our argument; provided we allow the maxim, that there must be a First Cause, to be necessarily and evidently true; whether it be thought better to speak of it as an independent Axiom, or to consider it as derived from the general Axiom of Causation.

12. Thus we necessarily infer a First Cause, although the Palætiological Sciences only point *towards* it, and do not lead *to* it. But I must observe further; that in each of the series of events which form the subject of Palætiological research, the First Cause is the *same*. Without here resting upon reasoning founded upon our Conception of

a First Cause, I may remark that this identity is proved by the close connexion of all the branches of natural science, and the way in which the causes and the events of each are interwoven with those which belong to the others. We must needs believe that the First Cause which produced the earth and its atmosphere is also the Cause of the plants which clothe its surface; that the First Cause of the vegetable and of the animal world are the same; that the First Cause which produced light produced also eyes; that the First Cause which produced air and organs of articulation produced also language and the faculties by which language is rendered possible: and if *those* faculties, then also all man's other faculties;—the powers by which, as we have said, he discerns right and wrong, and recognizes a providential as well as a natural course of things. Nor can we think otherwise than that the Being who gave these faculties, bestowed them for some purpose;—bestowed them for that purpose which alone is compatible with their nature:—the purpose, namely, of guiding and elevating man in his present career, and of preparing him for another state of being to which they irresistibly direct his hopes. And thus, although, as we have said, no one of the Palætiological Sciences can be traced continuously to an origin, yet they not only each point to an origin, but all to the same origin. Their lines are

broken indeed, as they run backwards into the early periods of the world, but yet they all appear to converge to the same invisible point. And this point, thus indicated by the natural course of things, can be no other than that which is disclosed to us as the starting point of the providential course of the world; for we are persuaded by such reasons as have just been hinted, that the Creator of the natural world can be no other than the Author and Governor and Judge of the moral and spiritual world.

13. Thus we are led, by our material sciences, and especially by the Palætiological class of them, to the borders of a higher region, and to a point of view from which we have a prospect of other provinces of knowledge, in which other faculties of man are concerned besides his intellectual, other interests involved besides those of speculation. On these it does not belong to our present plan to dwell: but even such a brief glance as we have taken of the connexion of material with moral speculations may not be useless, since it may serve to show that the principles of truth which we are now laboriously collecting among the results of the physical sciences, may possibly find some application in those parts of knowledge towards which men most naturally look with deeper interest and more serious reverence.

OF THE SUPREME CAUSE.

The first Induction of a Cause does not close the business of scientific inquiry. Behind proximate causes, there are ulterior causes, perhaps a succession of such. Gravity is the cause of the motions of the planets; but what is the cause of gravity? This is a question which has occupied men's minds from the time of Newton to the present day. Earthquakes and volcanoes are the causes of many geological phenomena; but what is the cause of those subterraneous operations? This inquiry after ulterior causes is an inevitable result from the intellectual constitution of man. He discovers mechanical causes, but he cannot rest in them. He must needs ask, whence it is that matter has its universal power of attracting matter. He discovers polar forces: but even if these be universal, he still desires a further insight into the cause of this polarity. He sees, in organic structures, convincing marks of adaptation to an end: whence, he asks, is this adaptation? He traces in the history of the earth a chain of causes and effects operating through time: but what, he inquires, is the power which holds the end of this chain?

Thus we are referred back from step to step, in the order of causation, in the same manner as,

in the palætiological sciences, we were referred back in the order of time. We make discovery after discovery in the various regions of science; each, it may be, satisfactory, and in itself complete, but none final. Something always remains undone. The last question answered, the answer suggests still another question. The strain of music from the lyre of Science flows on, rich and sweet, full and harmonious, but never reaches a close: no cadence is heard with which the intellectual ear can feel satisfied.

In the utterance of Science, no cadence is heard with which the human mind can feel satisfied. Yet we cannot but go on listening for and expecting a satisfactory close. The notion of a cadence appears to be essential to our relish of the music. The idea of some closing strain seems to lurk among our own thoughts, waiting to be articulated in the notes which flow from the knowledge of external nature. The idea of something ultimate in our philosophical researches, something in which the mind can acquiesce, and which will leave us no further questions to ask, of *whence*, and *why*, and *by what power*, seems as if it belonged to us;—as if we could not have it withheld from us by any imperfection or incompleteness in the actual performances of science. What is the mean-

ing of this conviction? What is the reality thus anticipated? Whither does the development of this Idea conduct us?

We have already seen that a difficulty of the same kind, which arises in the contemplation of causes and effects considered as forming an historical series, drives us to the assumption of a First Cause, as an Axiom to which our Idea of Causation in time necessarily leads. And as we were thus guided to a First Cause in order of Succession, the same kind of necessity directs us to a Supreme Cause in order of Causation.

On this most weighty subject it is difficult to speak fitly; and the present is not the proper occasion, even for most of that which may be said. But there are one or two remaks which flow from the general train of the contemplations we have been engaged in, and with which this Work must conclude.

We have seen how different are the kinds of cause to which we are led by scientific researches. *Mechanical Forces* are insufficient without *Chemical Affinities;* Chemical agencies fail us, and we are compelled to have recourse to *Vital Powers;* Vital Powers cannot be merely physical, and we must believe in something hyperphysical, something of the nature of a *Soul.* Not only do biological inquiries

lead us to assume an animal soul, but they drive us much further; they bring before us *Perception*, and *Will* evoked by Perception. Still more, these inquiries disclose to us *Ideas* as the necessary forms of Perception, in the actions of which we ourselves are conscious. We are aware, we cannot help being aware, of our Ideas and our Volitions as belonging to *us*, and thus we pass from *things* to *persons;* we have the idea of *Personality* awakened. And the idea of Design and *Purpose*, of which we are conscious in our own minds, we find reflected back to us, with a distinctness which we cannot overlook, in all the arrangements which constitute the frame of organized beings.

We cannot but reflect how widely diverse are the kinds of principles thus set before us;—by what vast strides we mount from the lower to the higher, as we proceed through that series of causes which the range of the sciences thus brings under our notice. Yet we know how narrow is the range of these sciences when compared with the whole extent of human knowledge. We cannot doubt that on many other subjects, besides those included in physical speculation, man has made out solid and satisfactory trains of connexion;—has discovered clear and indisputable evidence of causation. It is manifest, therefore, that, if we are to attempt to ascend to the Supreme Cause—if we are to try

to frame an idea of the Cause of all these subordinate causes;—we must conceive it as more different from any of them, than the most diverse are from each other;—more elevated above the highest, than the highest is above the lowest.

But further;—though the Supreme Cause must thus be inconceivably different from all subordinate causes, and immeasurably elevated above them all, it must still include in itself all that is essential to each of them, by virtue of that very circumstance that it is the Cause of their Causality. Time and space,—Infinite Time and Infinite Space,—must be among its attributes; for we cannot but conceive Infinite Time and Space as attributes of the Infinite Cause of the Universe. Force and Matter must depend upon it for their efficacy; for we cannot conceive the activity of Force, or the resistance of Matter, to be independent powers. But these are its lower attributes. The Vital Powers, the Animal Soul, which are the Causes of the actions of living things, are only the Effects of the Supreme Cause of Life. And this Cause, even in the lowest forms of organized bodies, and still more in those which stand higher in the scale, involves a reference to Ends and Purposes, in short, to manifest Final Causes. Since this is so, and since, even when we contemplate ourselves in a view studiously narrowed, we still find that we have

Ideas, and Will and Personality, it would render our philosophy utterly incoherent and inconsistent with itself, to suppose that Personality, and Ideas, and Will, and Purpose, do not belong to the Supreme Cause from which we derive all that we have and all that we are.

But we may go a step further;—though, in our present field of speculation, we confine ourselves to knowledge founded on the facts which the external world presents to us, we cannot forget, in speaking of such a theme as that to which we have thus been led, that these are but a small, and the least significant portion of the facts which bear upon it. We cannot fail to recollect that there are facts belonging to the world within us, which more readily and strongly direct our thoughts to the Supreme Cause of all things. We can plainly discern that we have Ideas elevated above the region of mechanical causation, of animal existence, even of mere choice and will, which still have a clear and definite significance, a permanent and indestructible validity. We perceive as a fact, that we have a Conscience, judging of Right and Wrong; that we have Ideas of Moral Good and Evil; that we are compelled to conceive the organization of the moral world, as well as of the vital frame, to be directed to an end and governed by a purpose. And since the Supreme Cause is the

cause of these facts, the Origin of these Ideas, we cannot refuse to recognize Him as not only the Maker, but the Governor of the World; as not only a Creative, but a Providential Power; as not only a Universal Father, but an Ultimate Judge.

We have already passed beyond the boundary of those speculations which we proposed to ourselves as the basis of our conclusions. Yet we may be allowed to add one other reflection. If we find in ourselves Ideas of Good and Evil, manifestly bestowed upon us to be the guides of our conduct, which guides we yet find it impossible consistently to obey;—if we find ourselves directed, even by our natural light, to aim at a perfection of our moral nature from which we are constantly deviating through weakness and perverseness;—if, when we thus lapse and err, we can find, in the region of Human Philosophy, no power which can efface our aberrations, or reconcile our actual with our ideal being, or give us any steady hope and trust with regard to our actions, after we have thus discovered their incongruity with their genuine standard;—if we discern that this is our condition, how can we fail to see that it is in the highest degree consistent with all the indications supplied by such a philosophy as that of which we have been attempting to lay the foundations, that the Supreme Cause, through whom man exists as a moral being of vast capacities

and infinite hopes, should have Himself provided a Teaching for our ignorance, a Propitiation for our sin, a Support for our weakness, a Purification and Sanctification of our nature?

And thus, in concluding our long survey of the grounds and structure of Science, and of the lessons which the study of it teaches us, we find ourselves brought to a point of view in which we can cordially sympathize, and more than sympathize, with all the loftiest expressions of admiration and reverence and hope and trust, which have been uttered by those who in former times have spoken of the elevated thoughts to which the contemplation of the nature and progress of human knowledge gives rise. We can not only hold with Galen, and Harvey, and all the great physiologists, that the organs of animals give evidence of a purpose; —not only assert with Cuvier that this conviction of a purpose can alone enable us to understand every part of every living thing;—not only say with Newton that "every true step made in philosophy brings us nearer to the First Cause, and is on that account highly to be valued;"—and that "the business of natural philosophy is to deduce causes from effects, till we come to the very First Cause, which certainly is not mechanical:"—but we can go much further, and declare, still with

Newton, that "this beautiful system could have its origin no other way than by the purpose and command of an intelligent and powerful Being, who governs all things, not as the soul of the world, but as the Lord of the Universe; who is not only God, but Lord and Governor."

When we have advanced so far, there yet remains one step. We may recollect the prayer of one, the Master in this School of the Philosophy of Science: "This also we humbly and earnestly beg; —that human things may not prejudice such as are divine;—neither that from the unlocking of the gates of sense, and the kindling of a greater natural light, anything may arise of incredulity or intellectual night towards divine mysteries; but rather that by our minds, thoroughly purged and cleansed from fancy and vanity, and yet subject and perfectly given up to the divine oracles, there may be given unto Faith the things that are Faith's." When we are thus prepared for a higher teaching, we may be ready to listen to a greater than Bacon, when he says to those who have sought their God in the material universe, "Whom ye ignorantly worship, Him declare I unto you." And when we recollect how utterly inadequate all human language has been shown to be, to express the nature of that Supreme Cause of the Natural, and Rational,

and Moral, and Spiritual world, to which our Philosophy points with trembling finger and shaded eyes, we may receive, with the less wonder but with the more reverence, the declaration which has been vouchsafed to us:

In the Beginning was the Word, and the Word was with God, and the Word was God.

THE END.